THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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THE

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ACCIDENTS DUE TO ELECTRICAL SHOCK.

CONSIDERING the magnitude of the electrical industry in all its various branches, and the number of men engaged in connection with tramway work, lighting and power, it cannot be justly urged that the number of fatal accidents due to electrical shock is sufficient to create serious uneasiness either with those engaged in the profession or with the public generally. At the same time it must be admitted that as such accidents are becoming more frequent, it is the duty of the profession to take the initiative in doing everything in its power to protect its members as well as the public.

The constant increase in the use of high and extra high pressure must of necessity increase the risk to life, but it must also be remembered that a comparatively small pressure may prove fatal under certain conditions of contact or where the victim is suffering from neurosis or cardiac affection. In our present state of comparative ignorance of such matters, it is impossible to say definitely what does or does not constitute a dangerous pressure, and this is demonstrated by the well-known fact that shocks, with good contact, at 2,000 volts or over have, with the exception of more or less serious burns, left the victim practically uninjured, while, on the other hand, under somewhat exceptional circumstances a shock at less than 200 volts has proved fatal.

The varied conditions under which accidents occur render it absolutely impossible to entirely prevent casualties, as complicated combinations of circumstances which cannot be foreseen are sometimes the cause. Isolating, protecting, and fencing of dangerous plant, is to some extent necessary and desirable, but the utmost care and discretion has to be exercised in order to prevent such means becoming indirectly a greater source of risk. Fencing and covering up not infrequently render necessary operations more difficult to the attendants, and consequently produce a feeling of nervousness or uncertainty which is fatal to safety.

All the methods of protection suggested by the Government Departments from time to time have taken the form of covering up, fencing, or isolating the dangerous plant. Such measures are alone quite inadequate to prevent accidents, and in some cases may increase the risk, while the officers in charge of, or responsible for, carrying out such measures risk prosecution in case of non-compliance. Under the Public Health (London) Act (Smoke Prevention) provided the owners of works provide apparatus for the prevention of smoke, the men operating such appliances can be fined for negligence or improper use of the same, and the principle should be extended to men engaged in dangerous trades.

It goes without saying that all unskilled men should be rigidly excluded from the vicinity of danger, particularly live wires, connections or other parts, or when

it is imperative for them to work within the danger zone, they should be placed under the strict supervision of a responsible technical officer. Rules or regulations, however, can do little more than reduce the risk, as numerous accidents are caused by direct disobedience resulting in serious or fatal accident. There is also to be taken into consideration error in judgement or mental aberration on the part of the officer responsible, even when the charge of culpable negligence would be unjust. Cases have occurred where a skilled technical officer has been required to disconnect a cable, transformer or other apparatus in order to enable a workman to effect alteration or repairs, and has been quite confident that he has done so, but has mistaken the connection and instructed the workman to proceed with his work on *a live part*, with the inevitable result of an accident more or less serious.

It is not only the technical officer, however, that is at fault; men have frequently disobeyed orders directly and specifically given by their chief, and the only punishment in the power of the latter is to dismiss the offending man, which has but little effect in bringing the remaining staff to a proper sense of their duties, and frequently does not affect the man who fills the vacancy at all. Many men disregard the rules for their protection, not only after repeated warnings, but after they have suffered more or less severely for their folly. Familiarity breeds not only contempt, but thoughtlessness, and even carelessness, and in this skilled technical men are often equally culpable with their less accomplished staff. Although accidents to technical men are comparatively rare, they are by no means unknown, and while a feeling of uneasiness and responsibility sometimes engenders nervousness and probable accident, undue confidence, familiarity, or absence of mind, are far more liable to result in disaster, and have been the prime causes of accidents of this character.

The question of how to entirely prevent accident, is one that, with a fallible humanity, it is hopeless to consider, but that measures can be taken to largely minimise them is certain, provided it is proceeded with on proper and consistent lines. It is useless to expect the Home Office or Board of Trade to prevent accidents or even to minimise their occurrence to any appreciable extent; both bodies are, to a large extent irresponsible, and the best they have done is to issue multifarious regulations of a more or less impracticable character, which, when adopted, have shifted or increased the responsibility upon those who are powerless to enforce them. An interim report of the Select Committee of the Home Office upon dangerous trades—electricity works—published some years ago, contained certain recommendations, many of which were impracticable, if not absurd, and others which would increase the responsibility of the chief engineers without considering the responsibility of the staff at all. The mountain in labour brought forth a molehill, and the proposed regulations have been shelved, if not forgotten.

In our opinion the whole matter of accidents due to electrical shock should be seriously taken up by a Special Committee nominated by the Institution of Electrical Engineers, and powers provided to enable them to obtain evidence upon oath if deemed desirable. From the evidence collected, a valuable set of regulations might be framed, dealing not only with the responsibility of the employer and management, but giving them power to enforce such regulations amongst their staff, or obtain punishment for their default in a Court of Summary Jurisdiction. A short Bill could be promoted for the purpose. In the meantime a few suggestions may not be out of place:—

1. All dangerous or live parts should be enamelled bright red, and notices prohibiting any unauthorised person coming within 6 or 10 ft. (depending upon circumstances) should be printed large and fixed in a conspicuous position.

2. All dangerous or "live" parts should be protected against *accidental contact as far as is consistent with convenient operation, but the operator should on no account be unnecessarily hampered in his work by guards, covers, or fences.*

3. No unskilled workman should ever be allowed within the danger zone, and skilled workmen should only be admitted in charge of a technical officer and acting directly under his supervision.

4. The use of rubber gloves should be insisted upon when working within the danger zone—*whether the parts are "live" or not*—and all parts to be worked upon should be efficiently and securely earthed after having been disconnected by a responsible officer.

(N.B.—The portion in italics may occasionally have to be modified at the discretion of a responsible officer when the parts are "dead" and earthed.)

5. The person required to use rubber gloves should be made responsible for seeing that they are in good condition and should refuse to use them unless they are quite sound.

6. Technical officers must cultivate calmness and presence of mind under all circumstances, and ever remember that not only their own lives but the lives of their staff are largely in their care.

7. Instant dismissal should in every case follow a deliberate breach of the regulations.

8. Frequent first aid and resuscitation drill should be practised by as many officers and members of the staff as possible.

The *Electrical Review* of New York for August 26th, refers to a paper on "Electric Shock," read by Mr. E. E. Noble, construction superintendent to the Cleveland Electric Illuminating Co., before the Ohio Electric Light Association, which deals in part with certain experiments on animals, the current being taken from a supply at 2,300 volts. From the results certain conclusions are arrived at, but as no details are given in the *Review*, it is impossible to express any opinion either upon the conclusions or the methods adopted in carrying out the experiments. It would, however, appear obvious that any experiments carried out either upon animals or human beings must be comparatively valueless on account of the number of factors involved and the impossibility of knowing all the conditions. The resistance of the skin varies constantly, while the contact may be good or bad in varying degrees. Again the shock may be at a pressure very much higher or lower than that of the original source of supply due to inductive effects, capacity discharges, shunts and many other causes. Mr. Noble is of opinion "That an important factor in a fatal electric shock is the action of the current upon the heart itself, and unless a relatively large part of the current passing through the body traverses the heart, the shock may not prove fatal."

It is questionable however, whether he is right in this assumption as the cross-section of the heart is small in proportion to the cellular tissue of the body as a whole, and therefore the greater part of the current would probably be shunted. This is, however, not a matter upon which anyone should dogmatise; at the same time there is evidence that as a rule the paralysing effect of the current upon the nervous system, including the solar plexus, is responsible for suspension of animation, if not death, and that the stoppage of the heart and lungs, being paralysed, naturally follows.

The discoloration of the skin usually noticed may be due to the electrolysis of the blood in the capillaries, especially if the skin is moist with perspiration, or it may be due, at any rate in some cases, to electrolysis of the blood generally. The peculiar tarry consistence of the blood lends colour to this assumption.

Assuming, however, that Mr. Noble's idea is correct, his proposed remedy is hardly practicable. He says "if some method can be devised for diverting the greater portion of the current around the heart, the number of deaths from electric shock will be greatly lessened, perhaps almost eliminated." Of course, this idea is a very old one, and a heavy metallic conductor passing from metal bracelets on the wrists along the arms and down the body to metallic soles on the boots has not only been suggested long ago, but, we believe, has been used, although we are not aware that anyone has been bold enough before to suggest encasing an average workman in a shirt of mail next his skin. We think that if the American workman would consent his English *confrères* would certainly object.

Metallic shields or protectors about the body are far more likely to cause accident than to avert it, and the condition of an unfortunate workman who succeeded in short-circuiting a power station plant, if the automatic cut-outs failed to act, may be better imagined than described. As already suggested, it is wiser to insulate a workman, earth the parts operated upon, and allow him only to work under the strict and constant supervision of a technical officer.

We give on another page a list of the accidents which have occurred since July, 1904.

Concerning Statistics of Internal Trade.

Arising out of a controversy which has recently been waged in our "Correspondence" columns between the chairman of one of our large manufacturing companies and one of his critics—a correspondence which began with quotations of figures of import trade and which concluded with the ethics of the question known as fiscal—a correspondent (whose letter we published in our issue of September 8th) wrote to us suggesting that a committee of members of the Institution of Electrical Engineers who belong to the Royal Statistical Society, should be delegated by the Council of the Institution to inquire into the subject of the compilation of commercial electrical statistics. The suggestion has such potentialities, that we feel inclined to point out the limitations and parallel precedents for the collecting of such information.

In these columns—and to an even greater extent in the pages of our contemporaries—Mr. W. Pollard Digby has asked from time to time for the collection of statistics of internal trade. It must not be imagined that the need for these is a discovery of Mr. Digby's, although the emphasis which he has laid upon their deficiency might lead some people to think so. In a measure—a poor one it is true—the statistics of our railway systems roughly indicate the extent of our internal activities in any year. Railway statistics, compiled with the minute detail which characterises the enumerations of the Government of India, go even further, as, in addition to dealing with total volumes carried, the weights of specific articles, raw and manufactured (to a total number of 35 main and numerous sub-headings), are recorded in each year.

The statistical registers of certain of our self-governing Colonies go further still, for they contain particulars of the numbers of factories of different classes, the number and sex of the hands employed, the amount paid in wages, the horse-power of the plant installed (whether steam, electric, water or gas driven), the capital value of the site and of the machinery installed, the value of the raw materials received (including fuel and semi-manufactured articles for working up) and the total value of the works output during the year. Voluntary efforts on a smaller scale among certain trade associations in this country, such as the British Iron Trades' Association, have collected for the information of their members, particulars of the volume of the output of certain articles. We believe the Alkali Manufacturers' Association does the same thing. These reports are private, and to secure a perusal of them is no easy matter.

In the collecting of such statistics by a Government Department, a natural reticence exists on the part of the manufacturer for fear of disclosing information regarded as confidential. In the case of small industries in which the number of factories could be counted on one hand, we find, in certain of the Registers which we have studied, that such information is not published. In the United Kingdom the electrical industry is a large one, and it would not be impossible to devise schedules which should measure the value of the total factory output under certain headings, and at the same time anonymously and discreetly shield the identity of the firms in question. A strong sub-committee deputed by the Council of the Institution of Electrical Engineers, with each member bound in honour to secrecy, could deal with the matter expeditiously and efficiently. Then we should have internal and external trade shown in their right proportions.

Sooner or later, Parliament will follow the example of the self-governing Colonies, and insist on returns of this nature. At present, however, the Imperial Parliament has a greater affection for grouse shooting than the establishment of a Ministry of Commerce, or the third reading of Electric Power Bills. We therefore turn to the Council of the Institution, and ask whether a tentative appointment of such a sub-committee might not be made?

Danger of Incandescent Lights and Coal-Dust.

The *Colliery Guardian* cites some tests made by Mr. H. Hall, H.M. Inspector of Mines, upon the immersion of an incandescent lamp in fine coal-dust from the Arley and Orrell Five-Feet Mines.

In one instance, after the lamp had been buried an hour and a half, the temperature rose to 700° F., and smoke was produced. In another hour the dust was red-hot and caked where the lamp had been lying, and gas and smoke issued for half an hour afterwards.

An incandescent lamp under ordinary atmospheric conditions will not become very hot, because it is able to radiate freely, and can part with all the heat it generates without rising to a dangerous degree of temperature above its surroundings. But coal-dust is an insulating material—a heat-insulator we mean—and since the lamp can no longer throw off heat freely, such heat must accumulate until the temperature attains a dangerous elevation. A curious fact noticed was that in one case where the lamp failed and the current ceased to pass, the temperature rose more than 200° in the half hour following the explosion, which seems to show that, once heated, the dust continued to oxidise. It is obvious that dangerous fires may be caused by the incandescent lamp, even if laid upon a heap of dust.

One of the constituents of coal gas, namely, methane, ignites at 650° C. This is much higher than any lamp will attain if not buried, and a simple safeguard for ordinary use should be found in the ordinary four-bar cage with which lamps are employed about boilers. Such a cage would hold the lamp from actual contact with any neighbouring substance and enormously diminish risk. The primary fact to bear in mind is, that however small a source of heat may be, the heat is cumulative where the surroundings are non-conducting, and with a perfect non-conductor there is no limit of temperature short of the temperature of the filament itself.

Bituminous coal-dust has been ignited even by sparks from a brake rim. There is no real danger from the heat of the lamp freely suspended, but it is as well that the dangers of buried or half buried lamps should be known.

D

ELECTRIC SHOCK FATALITIES.

The following is a list of the fatal electric shock accidents that have occurred in the United Kingdom from July 28th last year up to date, and have been reported in our columns. We have not included the fatal third-rail accidents on electric railways :—

Date of accident.	Occupation of victim.	Character of accident.
July 28, 1904	Ironworks labourer (Acklam Ironworks).	Grasped at electric lamp to save fall.
Aug. 19, „	Labourer (Metropolitan Electric Supply Co.).	Putting in new cable at manhole at Manchester Square. Cutting pipe. Current on at time. No gloves used (500 volts).
Sept. 6, „	Engineer, watching readings during test of turbo-generator at Walker-on-Tyne.	Came into contact with brushes (300 volts).
Sept. 21, „	Colliery employé (Ferryhill, Durham).	Received shock when grasping bare "Rapper" signal wire; leakage from temporary wiring. 220 volts; damp.
Sept. 27, „	Sub-station employé, apprentice, aged 18 (Scarborough Electric Light Co.).	Dusting switches with gloves on; found dead with head 3 in. from nearest terminal; left hand hanging by side. 130 volts.
October „	Miner (aged 21) employed Eldon Colliery, Bishop Auckland.	Found dead grasping electric cable supplying current to coal-cutting machines.
Jan. 6 1905	Clockwinder at work in Leeds Market Hall clock tower (weak heart).	Clock gong operated by current from lighting mains (200 volts alternating); clockwork electrified at intervals.
Feb. 8 „	Foreman electrical engineer (Bolckow, Vaughan & Co., Middlesbrough).	Searching for leakage under engine house, touched live wire and fell into well.
Jan. 28 „	Electric pump driver at colliery at Tredegar.	Fuse nipped between lid and case of c.i. fuse box; ineffective earthing.
April 7 „	Senior shift engineer Islington electricity works.	Received shock whilst adjusting rectifier, 1,500 to 2,000 volts; no gloves used.
May 26, „	Bricklayer's labourer (Gateshead Railway shops).	Employed on crane sweeping walls; grasped wire presumably to prevent falling.
June 23, „	Master electrician (Kennington).	Employed in basement of premises adding an extra light. Cut wire with pliers when current on; earth damp; nails in boots; 200 volts.
June 27, „	Workman at Tube Works, Airdrie.	Found dead across iron rail guarding electric switch of scarfing machine.
July 17, „	Electrician at Neasden Power Station.	Entangled among live wires in transformer chamber; chamber not locked, but instructions not to enter; 11,000 volts.
Aug. 18, „	Bricklayer. District Railway sub-station, Whitechapel.	Removing floor-plates in sub-station; chamber not locked. Assumed plate caught on feeder switch.
Aug. 28, „	Electrician, employed high tension chamber, Hastings Tramways.	Chamber kept locked; deceased, after pointing out dangerous parts to labourer, accidentally brought his own hand into contact with live part of switch.

New Zealand.—The New Zealand Customs authorities have lately given a decision to the effect that "carbon plates for galvanic batteries" are to be classified as "machinery, electrical and appliances," the duty being 10 per cent. *ad valorem*.

NOTES ON THE LOCALISATION OF CABLE FAULTS.

By HENRY JOSEPH.

So much has been written lately on the subject of the final localisation of faults on underground mains, and so much personal recrimination has been mixed up with the various items of information which have been recorded, that it is with some degree of trepidation that the present writer enters the lists.

The object of this article is not so much to suggest new methods, as to investigate the conditions under which tests already published are likely to be useful, and to ascertain, if possible, what steps should be taken to find the position of a fault, the nature of which is such that no test known to the writer can be applied with any degree of certainty.

In writing these notes, the author has in mind more particularly the conditions appertaining to a three-wire continuous current system with the neutral earthed at the station.

On such a system, the faults may be roughly divided into three classes, irrespective of the kind of cable :—

1. An earth on one or more conductors, but no break of continuity.
2. A short between two or more conductors, but no earth or break of continuity.
3. A length of cable completely burnt out.

I.—An Earth on one or more Conductors, but no Break of Continuity.

An Earth on One Conductor.—This may be a fault detected in its early stages, and is, on the whole, the simplest to localise, it being the ideal condition under which a loop test may be taken. This is probably the most accurate and reliable test for this class of fault, since its accuracy depends

Fig. 1.

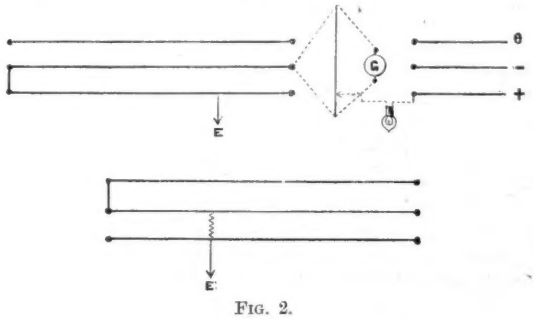


Fig. 2.

only on the homogeneity of the cable, testing leads, and slide wire. As this test is doubtless familiar to most of your readers, it will not be necessary to describe it. Fig. 1 shows the modification used by the writer, the supply in series with a lamp being used instead of a battery, and the current returning through the fault and earth to the middle wire at the station.

An Earth on Two Conductors.—The same method is applicable in the case of an earth on two conductors, the sound one being used to complete the loop with either of the faulty ones (fig. 2).

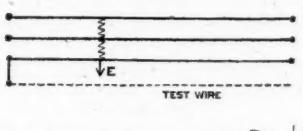
An Earth on all Conductors.—If all three conductors are earthed, it is necessary to run a test wire over ground in order to complete the loop with one of the faulty conductors (as in fig. 3), and as its section should, in order to ensure accuracy, be comparable with that of the cable under test, this method is not to be recommended, especially where the length of cable is long, or the thoroughfare a busy one.

Some fall of potential test, such as that suggested by your correspondent "B. S. H." and others in recent issues of the Review, might be used in this as well as the two previous cases, but where all conductors were earthed, these methods would also require a test wire.

Fig. 4 shows a modification which gets over the difficulty. A current from an automobile accumulator, regulated by

means of a resistance, is sent through the fault. An ammeter is put in circuit, and voltage readings are taken simultaneously at either end of the cable. V_1 = fall of potential along two conductors + the fault, and V_2 = P.D. across the fault, whence the distance up to the fault can be

Fig. 3.



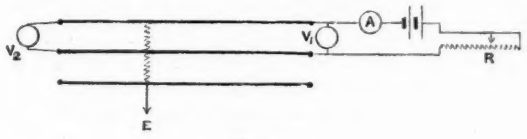


Fig. 4.

calculated from the known resistance of 1 yard of the cable in question.

Check readings should be taken between each of the three pairs, and the mean distance marked on the ground.

Similar readings should also be taken from the other end, and if the two points do not quite agree, the ground should be opened at a point midway between them.

As a further check, and to prevent confusion arising through an E.M.F. at the fault, the battery should be reversed, and another set of readings taken. Of course, the supply may be used through a bank of lamps, but the writer prefers a battery as it is more convenient, and is not liable to be upset by earth currents to the same extent.

The two voltmeters are ordinary cell testing instruments calibrated to the same standard.

II.—A Short between two or more Conductors, but no Earth or Break of Continuity.

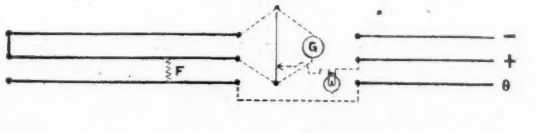
Where the fault consists of a short unaccompanied by an earth, a loop test can only be used if there is one sound conductor, as in fig. 5, or if it is possible to lay a test wire along the ground.

The voltmeter method is also applicable as in the previous case.

If the cable be a distributor, with a number of services, the following method is useful whether the conductors are earthed or not.

A steady current, either from the supply or a battery, is sent through the fault, and readings V_1, V_2, V_3, &c., taken at consumers' terminals, between two of the faulty conductors (assuming that the neutral is shorted on to one or

Fig. 5.



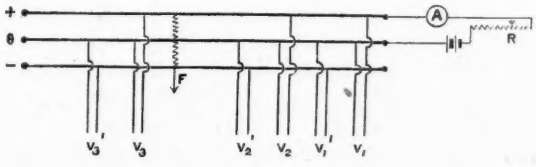


Fig. 6.

both of the outers). (See fig. 6.) These readings are taken at all service cut-outs along the whole length of the distributor, one set, V_1, V_2, V_3, &c., from positive services, and another set, V_1', V_2', V_3', &c., from negative ones, a tape being run from house to house at the same time.

These voltage readings will continue to fall as we get further from the source of supply, and will finally remain stationary when the fault has been passed, the final readings being the P.D. across the fault. A curve is now plotted, as in fig. 7, the ordinates being the voltage readings at, say, the positive consumers' terminals, another curve being plotted as a check for the negative ones.

The point, F, at which the sloping line crosses the horizontal one gives the position of the fault. The writer uses a small pad of sectional paper for this purpose, and has found this test exceedingly useful for localising a fault on a cable supplying a number of public lamps.

III.—A Length of Cable Completely Burnt out.

This is the most common type of fault on a system which is either not fused in the network boxes or is fused heavily, as, indeed, it should be, in order to keep the supply going in the event of a comparatively small fault, rather than try to save a few yards of cable from destruction.

In the case of a three-core or concentric armoured cable, this type of fault usually leaves only a charred mass sur-

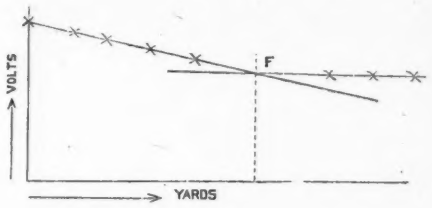


Fig. 7.

rounded by partially fused armour, the conductors at either end of the fault being fused into a solid lump with the armour, forming two earths of different resistances.

If the soil is wet, a P.D. may be set up between the steel and the copper, thus tending to confuse any attempt at a test.

If the cable be a distributor, we can proceed as in fig. 6, taking voltage readings at consumers' terminals in order to test for continuity, and to ascertain, when the fact that the cable is burnt out is determined, between which pair of services the break has taken place.

The readings will, of course, fall as we get nearer to the fault, and may finally fall to zero when it is passed, but the probability is that there will still be a P.D. owing to an E.M.F. at the fault on the *second* length of cable, which may be variable, and thus lead to some confusion.

To obviate this, the battery should be reversed, and a second set of readings taken. With care it should now be possible to definitely ascertain that the cable is severed, and to locate the fault as between two adjacent services, and finally to cut out the faulty length, and supply the consumers from either end, if the distributor be part of a ring.

If the length of cable thus made dead be a long one, or if it be a feeder, the difficulty now arises of finding the exact position of the fault. To do this the writer cannot suggest anything more scientific than cutting the cable half way and testing for the fault with a galvanometer, repeating the process, until the faulty length is reduced to one that can conveniently be relaid. Obviously no loop test is possible, since there is no available end of cable to short circuit, in order to complete the loop.

In the same way it is clear that any fall of potential test is out of the question, since we have to deal with two unknown quantities in the form of two shorts of unknown resistance.

Mr. Quin, in 1897, suggested a method in which two induction coils, with contact breakers of different lengths, were connected to either end of the cable, and a telephone receiver in series with a coil of wire was carried over the route of the cable. The fault was supposed to be found at a point where the notes from the two induction coils clashed.

All these telephone methods are liable to be upset by the armour of the cable, iron troughing, gas or water mains, in the ground, or stray currents from neighbouring tramway systems.

The writer would be glad to hear of any satisfactory test for a fault which has resulted in the severance of all con-

ductors, or of one or more of them without contact with the remainder.

So far the case has not been considered of one or more conductors being severed without a short or earth, but here again the same difficulties are found in applying a test.

The preliminary test at consumers' terminals—in the case of a distributor—is, of course, simplified by the fact that it is only necessary to apply a little "juice" at one end, and "feel" for continuity.

The writer has only once experienced this type of fault on a distributor, although several have occurred on public lamp services, through a bad consignment of cable being used; in this case the rubber apparently contained some foreign matter, which rotted away, and left a free passage for moisture which finally corroded the copper right through.

The distributor referred to above was a three-core ·1 in. fibre insulated, lead-covered cable fed from one end only, and it failed by corrosion in the same way, probably assisted by electrolytic action, through a hole in the lead.

Arcing had evidently taken place at the finish, and the distributor fuses blew, the conductors clearing themselves from earth and one another. Fortunately, the fault had occurred between two services within a dozen yards of one another and was thus quite easily found.

Another type of fault which is likely to be troublesome is an intermittent earth. This may occur through an accumulation of moisture setting up an arc which soon evaporates the water, or it may be caused by contact between a bare conductor and the edge of an iron trough, for instance. In either case it is more likely to occur on single conductors laid solid in metal troughing, or that most iniquitous system of single conductors pulled through iron pipes. If the fault will not develop sufficiently rapidly—indeed, it may remain as an intermittent one for weeks—it is advisable to earth one of the outers, and put the full voltage between the faulty main and earth, in the hope of rendering the earth a permanent one. One requires to think twice, however, before doing so, as it may involve finding out more faults in the district than one is prepared to attend to in the course of a day's work.

From what has gone before it should be clear that there is no standard test that can be applied to any class of fault in any particular district, although for many reasons local conditions may cause the mains engineer to have a preference for one particular method where it is applicable. He should, however, carefully guard against the mistake that is often made of using his favourite test without carefully investigating the nature of the fault, and then, when he has been misled, digging up and finding it with the pick and shovel.

It has been suggested that a jointer's hand-cart should be kept ready fitted up with all the necessary instruments and apparatus that are likely to be required, so that no time is lost in getting them together when required.

The writer would suggest a box to fit inside the hand-cart, the box to contain a graduated slide wire, a sensitive galvanometer, and a pair of leads long enough to reach from the ends of the slide wire to the terminals in a disconnecting box, of a section and length equivalent to a definite number of yards of ·1 cable; two 5-volt voltmeters with centre zero, an ammeter reading up to 20 amperes, and a 4-volt accumulator and regulating resistance (or, as an alternative, a bank of about two dozen 32-c.p. lamps, mounted on a board with batten holders); a wireman's galvanometer and spare leads for coupling up.

If this kit were kept ready for immediate use, and the precaution were taken of testing out all conductors for earths, shorts and continuity before commencing a test, much time would be saved, and much unnecessary and expensive excavation and cutting avoided.

Since writing the above the author has had the pleasure of reading a very interesting article by Mr. Knight in the Electrical Review on a similar subject,* and if the foregoing notes in places cover somewhat the same ground, he trusts that Mr. Knight will take them as supplementing his observations.

If one might be allowed to criticise the previous writer's valuable contribution, it would be to suggest that inaccuracies are likely to arise from introducing earth resistances into his calculations; for instance, his test on a loop-main is almost certain to be upset by the difficulty in obtaining *absolute* earth.

Surely it would be better and far quicker to cut the loop near the point at which it is fed, thus converting it into a single length, and apply an ordinary loop test. Cutting the cable will not be of any great consequence to consumers, and it can be re-jointed at leisure.

Mr. Knight's test (see fig. 4 in his second article) also has the disadvantage that it uses earth as a part of the loop, which, as he himself admits, may have a greater resistance than the cable itself.

This introduces into his calculations an element which, apart from its liability to variation, forms a large proportion of a small total resistance, and being difficult to measure accurately, is almost certain to completely upset the result. Would it not be better to use a test wire to complete the loop, as in fig. 3 above, if no other sound conductor is available?

Is it not also rather out of place to talk of making gnat-like temperature corrections for the resistance of the cable when inserting such very "camel-ious" factors as earth resistance?

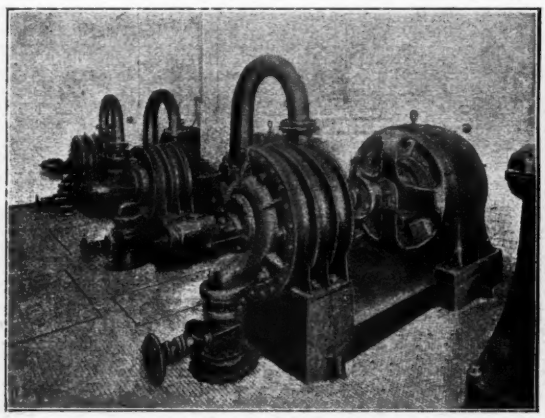


Fig. 1.—Pump Ends of the Turbine Units.

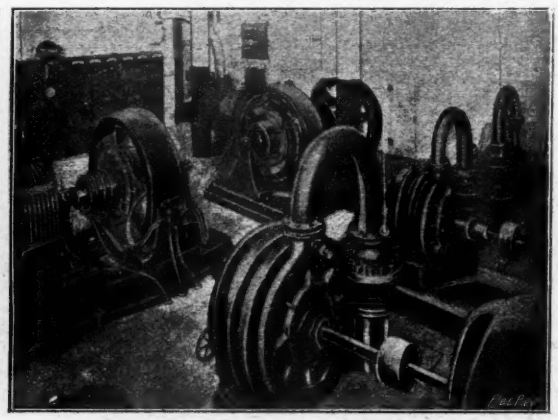


Fig. 2.—The Generators and Switchboard.

An Electro-Hydraulic Elevator Plant.

AN ELECTRO-HYDRAULIC ELEVATOR PLANT.

The provision of power for the elevators of large buildings is a problem which the architect has to solve in connection with the space that he has at his disposal. If current from

* Both MSS. were in our hands for some time before the publication of Mr. Knight's article.—Eds. E.R.

the electrical supply companies' mains is adopted, he can dispense with a power plant of gas or steam, and the space which either of these installations would require, and the attendance; the further consideration as to whether the elevators should be driven direct by motors or by hydraulic power has then to be taken into account, as the latter method has some advantages over the former.

The adoption of the electrically-driven turbine pump permits of dispensing with a complicated power installation while retaining all the advantages of the hydraulic system of manipulating the elevators; this system, while occupying very little space and attention, allows of noiseless and smooth working of the elevators. The accompanying illustrations show the electro-hydraulic installation in John Taylor Dry Goods Co.'s store, Kansas City, Mo.*

Fig. 1 shows three Worthington three-stage motor-driven turbine pumps operating the hydraulic elevator system of the store. Machines Nos. 1 and 2 are of 300 gallons per minute capacity each, driven by a 45-H.P. 220-volt motor, while No. 3 is of 500 gallons and driven by a 70-H.P. motor. Cutler-Hammer controlling apparatus is employed on the main switchboard. The pressure in the hydraulic mains is 140 lb. per sq. in., from which all the elevators of the store are supplied. During the light load requirements one of the 300-gallon units carries the service, and the heavier load is dealt with by the 500-gallon unit, while the maximum load is taken by either Nos. 1 and 3, or Nos. 2 and 3 together, or if the load is not up to full maximum, Nos. 1 and 2 may carry the service.

These pumps were selected from considerations of economy, noiseless operation and compactness. The nature of the turbine pump is such that a control device is not required, except from economical considerations, as it will work automatically, but the addition of the Cutler-Hammer controlling apparatus is considered a step towards greater economy.

* W. K. Palmer in the *Iron Trade Review*, Cleveland, Ohio.

ON THE PROPERTIES OF MAGNETS MADE OF HARDENED CAST-IRON.†

By B. O. PEIRCE.

DURING the last six or seven years a large number of d'Arsonval galvanometers, in which the permanent fields are due to hardened and artificially seasoned cast-iron magnets, have been used in the Physical Laboratory of Harvard University, in competition with similar instruments furnished with hardened forged-steel magnets from the shops of well-known makers. For nearly five years also magnets of the same kind have been employed in standard mirror amperemeters and voltmeters fixed in the laboratory, in cases where it was desirable that the indications of the instruments should be trustworthy within one part in a thousand of their larger deflections, over a considerable range of room temperatures. Besides the cast-iron magnets which we have made ourselves, we have of late used a number of others in moving-coil galvanometers purchased in the market—some of the best of them from the Leeds and Northrup Co.

It early appeared, from tests made on these instruments, that whereas good iron castings as they come from the foundry make most unsatisfactory magnets, so far as permanence is concerned, magnets made of castings properly hardened and aged after being machined—if machining is necessary for the purpose to which the magnets are to be put—compare favourably in strength, in permanence, and in the relatively small changes of their moments with room temperature, with the best of tool steel magnets, even if in strength, though not in their other qualities, they fall a little behind magnets made in a forming press of steel specially prepared for the purpose.

Although chilled cast-iron bar magnets have been used for a long time in a few forms of telephones, it is usually best to make straight magnets (which do not need to be hammered) of steel; but the forging of steel for permanent magnets of complex forms, without spoiling it, demands a kind of skill which most toolmakers, even in the largest establishments, have not acquired, and it is generally difficult to get satisfactory specimens of any very special shape of curved-steel magnets unless one has access to such facilities as a few of the manufacturers of electrical measuring instruments have provided for themselves. It is true that the hardening of iron castings for magnetic purposes also requires such skill as few persons possess, if the very best results are to be obtained, especially when the pieces to be treated weigh more than a pound or two; but a little practice will enable any good workman, who has a gas forge with blast powerful enough to raise the temperature of the iron uniformly nearly to the melting-point, to make good gray-iron castings of moderate size, hard enough for strong magnets, which will leave little to be desired so far as permanence is concerned. It has been my good fortune to have the help of Mr. G. W. Thompson, the mechanician of the Jefferson Laboratory, who has had long experience in treating cast-iron, and who has made for me, by a process of his own, massive magnets with extremely low temperature coefficients. It is to be noticed that some of the secret methods of hardening cast-iron, used by makers of small parts of machinery, do not fit the castings for making good magnets, and that case hardening, which affects the surface only, is useless. The character of the cold bath into which, while it is kept in violent agitation, the strongly heated castings to be hardened are plunged, seems to have considerable influence upon the result.

At the very high temperature, just under the melting-point, to which the cast-iron must be raised before it is suddenly chilled, the metal loses much of its tenacity, and slender pieces must be handled carefully lest they break like chalk. The chilled casting should be hard enough to scratch window glass, if not so readily as hardened tool steel will do it. It is vain to attempt to make any such gray-iron castings as I have used magnetically hard by chilling them after they have been heated to the comparatively low temperatures that one would use in making steel glass-hard. Everyone who has attempted to harden a thick mass of tool steel uniformly, knows how difficult the task is; it is easy enough to get the outer layers glass-hard, while the interior is much softer; or sometimes (by overheating the steel) to get the inside hard while the outside is blistered and cracked. If a casting is heated to a very bright red and then plunged into the bath, the outside may become hard to the file, while the interior, as magnetic tests clearly show, remains soft; in this case, however, the material will stand a higher temperature without injury, and if the mass be reheated and when it is just below the melting point be suddenly chilled, the whole interior becomes hard.

It is a good deal easier to harden a lot of straight, round pieces of good gray cast-iron, say 20 cm. long and 1 cm. in diameter, so that they shall all be nearly alike magnetically, than it is to do the same with an equal number of pieces of drill rod.

Several years ago, when I had to have a set of the best magnets I could get for measuring purposes, carefully ground into shape after the steel had been hardened, I experimented* upon hundreds of seasoned magnets made of many kinds of steel; ordinary tool steels, self-hardening tool steels, and special magnet steels. I found nothing better in tool steels than the Crescent drill rod, or the Jessop's black round tool steel, and I have used these as standards in testing my round cast-iron magnets.

Most of my experiments on the strengths of round cast-iron bar magnets have been made with pieces 18 cm. long and either 0·95 cm. or 1·25 cm. in diameter, of which I have a good many, some new and some cast two years ago. These were usually relaxed† after their hardening by being boiled in water for some time; next they were magnetised to saturation in a solenoid, and then they were again boiled and "aged" in the usual manner. The resulting magnets were finally tested in competition with a large number of seasoned tool steel magnets, of different brands, but all of the same dimensions as the castings, with the help of a mirror magnetometer. The cast-iron magnets looked, of course, rather rough in comparison with others made of polished rod, but their moments differed among themselves less than those of an equal number of the steel magnets made of any one brand. Just one of the tool steel magnets had a moment sensibly greater (about 4 per cent.) than any of the cast-iron magnets, but the average of the moments of the cast-iron magnets was rather greater than those of the steel, even after the records of the two or three steel magnets with abnormally low moments had been rejected.

Two years ago‡ I measured the temperature coefficients of a good many bar magnets of cast-iron and steel. In every instance, as was to be expected, the rate of loss of moment per degree of rise of temperature was much greater at temperatures near the boiling-point of water than at room temperatures, but if for purposes of comparison we used the mean loss, per degree, of the magnetic moment, when the magnet was heated from about 10° C. to 100° C., expressed in terms of the moment at the lower temperature, it appeared that in the case of rods 16 cm. long and 0·95 cm. in diameter, these mean losses were

0·00042 for seasoned, chilled, cast-iron magnets,
0·00046 for seasoned magnets made of Crescent steel drill rod or Jessop's round black tool steel,

while they were

0·00070 for seasoned magnets made of Jessop's square tool steel 16 cm. long, and of cross-section nearly that of the round rods.

In the case of shorter rods the difference was still more in favour of the castings, because, I suppose, they were more uniformly hardened in the interior than the steel could be.

If an iron casting which has been hardened and boiled is magnetised in a solenoid either to saturation or to a degree which falls much short of this, it is practically impossible to decrease the moment by even so little as a tenth of 1 per cent. by striking the magnet on end with a wooden mallet or with a stone. I have tested many such magnets by dropping each 200 or 300 times upon a stone slab, or by giving it hundreds of sharp blows with wooden clubs. The magnets

† *Proceedings* of the American Academy of Arts and Sciences, Vol. XL. No. 22, April, 1905. (Contributions from the Jefferson Physical Laboratory, Harvard University.) Abstract.

* Peirce, *American Journal of Science*, 1898, p. 334.

† Barus and Strouhal, *Bulletin* of the U.S. Geological Survey, No. 14, 1885.

‡ Peirce, *Proceedings* of the American Academy of Arts and Sciences, February, 1903.

get a little warm during this harsh treatment, but when their temperatures again fall to the original point the moments, which may have fallen a small fraction of 1 per cent., regain wholly, so far as my observations go, their old values. Some few of the specimens of special magnet steel that I have examined are nearly equal to the castings in this respect.

Prolonged boiling has, however, always reduced the moment of the cast-iron magnets very sensibly, and this loss may be as much as 20 per cent. when the magnetising field has been an extremely strong one, and the residual moment is very high; if the casting has not been magnetised to saturation, the loss of moment by boiling is much less. If, after a cast-iron magnet has been seasoned, its temperature be suddenly raised from room temperature to 100° C., and then as suddenly lowered, the magnet may not wholly recover its original strength until after the lapse of several hours; if, however, the upper limit be only 50° C., there seems to be no sensible lag in the attainment of the whole of the original moment.

Most of the steel made specially for magnets, which I have been able to get, has come in the form of long bars of rectangular cross-section, about 2 cm. wide and 1 cm. thick; of such steel I have had pieces 18 cm. long, hardened in some of the various ways used by professional magnet-makers, to compare with hardened castings of the same dimensions. One of the hardened but unmagnetised castings was placed in a solenoid, exposed to the action of a demagnetising alternating current, and then put rapidly two or three times through a hysteresis cycle, using a maximum field of 145·2 gausses. After this preliminary treatment—which I used in the case of every piece that I examined—the hysteresis diagram remained unchanged however many times the iron went through the cycle.

Fig. 1 represents hysteresis curves of (A) a piece of hardened cast-iron (18 cm. × 2 cm. × 1 cm.), and (B) of two pieces of Seebohm and Dickstahl magnet steel (of the same dimensions), which makes the strongest saturated magnets of any of the special steels which I have used. The maximum field in the case of the A curve and the larger B curve was nearly 166 gausses, and under this field the cast-iron and the special steel acquired moments of about 8,900 and 15,400 units respectively; when the field was removed the residual moments were about 3,120 and 3,550. The piece of steel just mentioned was hardened in a water bath; the smaller B diagram was obtained at another time with a similar piece of the same steel chilled in one of the baths used by Mr. Thompson. Although the maximum fields were unfortunately not the same in the two B diagrams, the general shapes of the curves are very similar.

These two pieces of steel and the cast-iron were then placed in a solenoid, the ends of each piece were connected together outside the coil by a massive iron yoke, and a current of about 45 amperes was sent through the coil; the residual moments of the cast-iron,

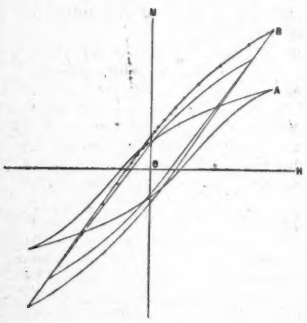


Fig. 1.

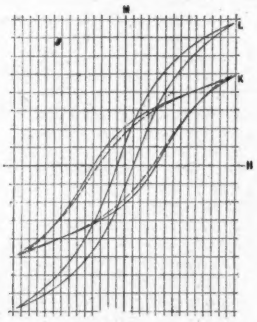


Fig. 2.

the steel chilled in water, and the steel hardened in the special bath were then about 4,390, 5,500 and 6,220. The weight of each piece of steel was approximately 274 grams. Of three other pieces of steel of a brand used exclusively by well-known makers of magnets for "magnetos," the first was hardened in plain water, the second treated with potassium ferrocyanide, the third chilled in Mr. Thompson's bath. These pieces, like those just described, were 18 cm. long, 2 cm. wide, and 1 cm. thick, and they retained, after being magnetised to saturation, the moments 3,470, 2,500 and 4,190 approximately; this steel was in our hands, therefore, not so good as the Seebohm and Dickstahl Special. The special magnet steels can be bent or formed, but cannot be heated hot enough for welding without spoiling the material for making magnets.

In fig. 2 the results of observations made by Mr. John Coulson and myself upon round cast-iron rods 18 cm. long and 0·95 cm. in diameter are shown. The rods were magnetised in a solenoid, of 4,927 turns in a length of 980 millimetres, placed with its axis horizontal and perpendicular to the meridian, and the relative moments at different times of the rod under investigation were determined. The abscissas represent the field (in tens of gausses) to which the rod is subjected by the current in the solenoid, the ordinates represent the corresponding magnetic moment of the rod in thousands of units. The L curve was obtained with a soft casting, the heavy K curve with a casing of the same lot which had been chilled from a high temperature in cold water. At the same time with this casting were hardened two or three pieces of Crescent drill rod of the same dimensions as it. These were naturally not exactly alike magnetically, but the best of them furnished the dotted K curve of fig. 2; the others had a very little less retentiveness. The magnetic likeness of the cast-iron and the steel is worthy of notice.

In fig. 3 the horizontal divisions represent, as before, the field in tens of gausses, the vertical divisions the corresponding moments of the specimens in thousands of units.

The C diagram was obtained with a soft casting 18 cm. long and ·95 cm. in diameter, the D curve with a casting of the same lot hardened by Mr. Thompson's methods. Another casting of the

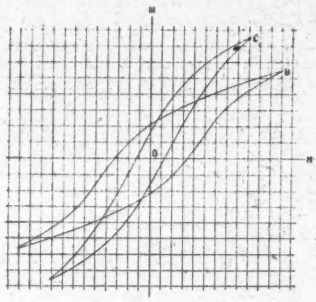


Fig. 3.

same set, hardened at the same time, gave the continuous curve in fig. 4, while a piece of Crescent drill rod, treated with the castings, furnished the dotted curve in the same figure. A careful comparison of the curves of figs. 3 and 4, obtained with the chilled castings—which were chosen from the lot wholly at

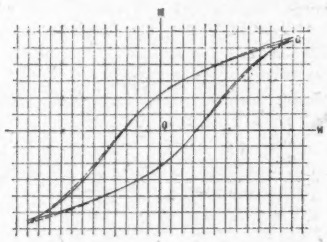


Fig. 4.

random—will show that they are magnetically almost indistinguishable; the likeness of the Crescent drill rod, chosen also at random, to the castings is again shown by the curves of fig. 4.

We have used cast-iron magnets of many different forms, a few of which only are shown in fig. 5; the shapes marked 1, 2, 3, 6 have been employed, with the long way of the opening between the poles vertical, in d'Arsonval galvanometers, while a number of rather thin plates of the shape marked 8 have been used together in other instruments of the same kind. Magnets of the shapes marked 5 and 7 produce the artificial fields in some mirror needle galvanometers used as voltmeters.

The mean temperature coefficient (K) between 10° C. and 100° C. of hardened magnets of the shape 1, which weigh 1,150 grams apiece, is about 0·00036; K is the mean loss per degree of the intensity of the magnetic field at any definite point between the

Fig. 6.

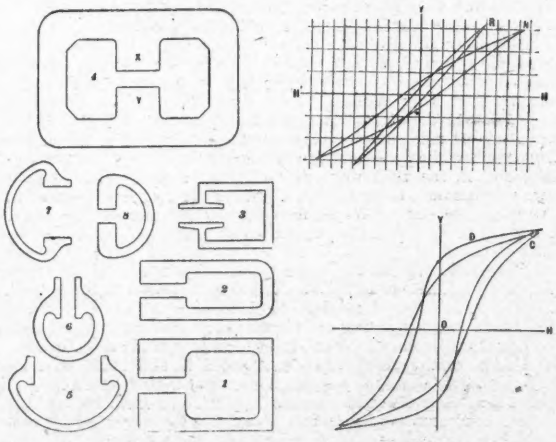


Fig. 5.

Fig. 7.

poles—when the magnet is heated from 10° to 100°—expressed in terms of the field intensity at the point at the lower temperature. For magnets of the shapes 3 and 6—which weigh 260 grams and 500 grams respectively—K has the values 0·00040 and 0·00031. The actual temperature coefficients at room temperature are always less than these mean values, and in the case of the last-mentioned

form the coefficient between 10° C. and 40° C. is not greater than 0·00013.

If the slender part of such a casting as No. 1 be wound as uniformly as possible with insulated wire, and if steady currents of different strengths be sent through this wire, the relative values of the whole magnetic induction across a given area between the poles can be determined with sufficient accuracy by pulling out, from a definite position between the jaws, a coil of suitable shape made of very fine manganin wire, and connected with a ballistic galvanometer.

In this way diagrams may be obtained very like the C and D curves of fig. 3, according as the casting is soft or hard, and this is a very delicate method of determining whether a casting which is hard on the surface is also hard throughout the interior. The two halves of each of two thick castings of the shape 4, weighing about 4,800 grams each, were wound as uniformly as we well could with 156 turns of insulated wire, and the two coils of

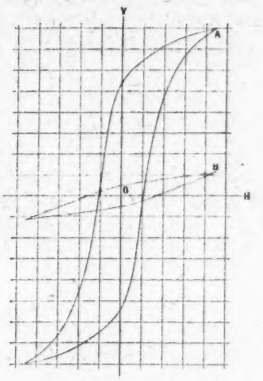


FIG. 8.

each casting were so connected in series that when a current was sent through them both conspired to make one of the projections (say X) a north pole and the other (Y) a south pole; one of the castings was soft, while the other, as another experiment afterwards proved, had been imperfectly hardened. With each of these castings a rough kind of hysteresis diagram was obtained by measuring for different current strengths the induction flux in the air between the poles; the ordinates in fig. 6 represent, in hundreds of lines per square centimetre, the induction across the centre of the gap, X Y, while the abscissas represent the current in the coils measured in amperes; the B curve belongs to the soft and the N curve to the supposed hard casting. In a second experiment made with the same castings, one of the coils on each was used as a primary and the other, which was connected with a ballistic galvanometer, as a secondary; this procedure gave the curves of fig. 7, which show clearly that the second casting, which was very hard to the file on the surface, was still soft inside. The diagrams of fig. 8, drawn on a different scale, give the results of a similar experiment on the soft casting just mentioned and a third chilled casting of the same form. These striking curves, which were reduced from a large drawing, represent the observations accurately, and illustrate the fact that it is possible to make the whole inside of a massive casting, like the one here used, magnetically very hard.

When the gap, X Y, of this third casting had been closed by a piece of soft iron, and a heavy current had been sent through the coils for a few moments, in such a way as to make one of the projections a north pole and the other a south pole, the casting became a fairly strong permanent magnet; the flux per square centimetre across the middle of the air-gap was finally 285. The flux per square centimetre across the gap of a similar, though considerably less heavy, hardened cast-iron magnet, belonging to one of a number of excellent d'Arsonval galvanometers furnished by Messrs. Leeds and Northrup, is 187. In this magnet the pole projections are a little shorter and the gap a trifle wider than in the castings 4 described above.

OUR LEGAL QUERY COLUMN.

[Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.]

"P. S. T." writes:—"A case has come to my notice which I should be glad to have your opinion upon. A certain works is situated just over the boundary of the area of supply of A in the area of supply of B. A's power station adjoins the works in question, while B's power station is some 1½ miles distant, and there is no immediate prospect of a cable being laid from B's works to give a supply.

"The question arises therefore whether the said works, having a cottage situated in A's area forming part of their works, would A be acting within their rights in laying a cable to the cottage, the works taking their supply from this point from A's power station?"*

*** It is provided by the Electric Lighting (Clauses) Act, 1899, Sched. Cls. 4, that undertakers shall not at any time after the commencement of the Special Order supply energy or (except for the purposes of that order) erect or lay down any electric lines or works beyond the area of supply otherwise than under the authority of Parliament, or under a licence granted by the Board of Trade under the principal Act. That is the letter of the law; and there is no case in the law reports which serves to show that the supply of *electricity* in the manner suggested by "P. S. T." would be an infringement of it. It is apprehended, however, that a Court of Justice would decree that there had been a colourable contravention of the Act; and this view is supported by a case which was decided in relation to the supply of gas. By the Metropolis Gas Act, 1860, Sec. 6, the limits of each gas company then supplying the metropolis were defined, and in the result each company enjoyed a virtual monopoly of its own district. One of these companies, at the request of a railway company, placed a meter on a part of a railway station lying within the company's limits, and through it supplied gas to other parts of the premises situated outside the company's limits, and within the limits of another company. The Court of Appeal held this to be lawful, on the ground that the sale and delivery of the gas took place at the meter; but the House of Lords reversed this decision, holding that the gas was supplied where it was consumed, and, therefore, that the company were transgressing their authorised limits (Gas Light and Coke Co. *v.* South Metropolitan Gas Co., 62 L.T. 126). In the circumstances "P. S. T." might incur some risk if he adopt the course suggested.

"J." writes:—"An application for a supply of current for one 16-C.P. lamp has been received from a consumer. The service is in the premises having been laid for a previous tenant. When the prices of supply were advertised no mention of a minimum charge was made, neither is it in the consumer's agreement, but there is a clause in this agreement as follows:—'Nothing in this agreement is to abridge or prejudice the rights and remedies of the Council under their provisional order and the Acts referred to therein.' I know that this light is only required for a specific purpose, and that the consumption of current will be so small as not to give any adequate return on the outlay, even for meter only. No charge is made for the hire of meters when accounts are paid within 21 days of demand.

"What I desire to know is whether, notwithstanding having advertised certain charges for current (without any minimum), the Council may, in a special instance like this, legally insist upon a minimum payment per quarter, sufficient, at any rate, to cover interest on their outlay, or refuse to supply at all. The following clauses are contained in the provisional order:—

"Clause 25, which provides that prices charged shall not exceed those specified in the schedule, and Clause 26, which reads as follows:—'Subject to the provisions of this order, and of the principal Act, and to the right of the consumer to require that he shall be charged according to some one or other of the methods above mentioned, the undertakers may make any agreement with a consumer as to the price to be charged for energy and the mode in which such charges are to be ascertained and may charge accordingly.'"

***A close examination of the provisional order under which the district council referred to by "J." supplies electricity, reveals nothing which will enable the council to impose an additional charge upon the consumer in question. Nor is there anything in the public Acts relating to the supply of electricity, which would enable them to impose special terms upon this consumer. Of course the case must be dealt with on the assumption that the mains have already been laid to the premises in question. Having regard, however, to the use which it is proposed to make of the current supplied, it is apprehended that the district council would be justified in refusing to give a supply. Upon their refusal, the consumer would have to go to the police court to enforce his rights, and it is probable that he would hesitate to adopt that course.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

A Milking Problem.

I am obliged to your correspondent, "C. P.," for pointing out my error *re* "milking."

Looking up my notes I find that the groups of low cells boosted in parallel happened to be some odd cells in places where the solid connections had been cut when the battery was divided into sections for another purpose. It was thus possible to cut out the second and third groups, the first only remaining in series with the battery.

* The editors regret that there has been some delay in answering this query owing to the absence of their legal contributor.

Of course, if the cells are solidly connected, only one group can be boosted at one time, although this may consist of any required number in series in any part of the battery, the booster volts being regulated by the exciter rheostat.

The booster can thus be used for "milking," its motor being run from the bus-bars, or, to secure perfect steadiness, connected across the ends of the battery.

Only in the case of the cell connections being movable, could more than one group be boosted in parallel.

Ralph W. Birkett.

Stockport, *September 8th*, 1905.

The Wiring Industry.

Mr. Munro's article under this heading in your last issue is hardly conclusive. Admitted that the present unsatisfactory state of the wiring industry is due to the fact that there is not sufficient work to go round, then we do not see how any combination of contractors is likely to improve matters, especially if, as Mr. Munro suggests, this combination should include as many contractors as possible. The only way in which such a combination as this can influence prices is by arranging some system of pooling, or, in other words, the formation of a Trust. For a Trust to be entirely successful it is necessary to eliminate every firm outside the Trust. Attempts of this nature have been made from time to time, not only in the electrical trade, but also in many others, but in no single instance has success attended any such enterprise. Depression in trade is very much like a famine, and no combination of starving men will help them to fill their stomachs if there is no food to be had. Under the present conditions, the question is probably one as much of individuality as anything else, and such work as there is, is usually secured by firms displaying reliability, enterprise and resource. The formation of Trusts rather tends towards the extinction of these qualities.

R. J. Nicholson & Co.

Manchester,
September 8th, 1905.

Compound Dynamos in Parallel.

In the Electrical Review of July 21st (page 90) I see that Mr. G. W. Weston, under the head of "Novel methods in Australia," refers to the connection of "compound" dynamos at Sydney station.

I have had the experience of an identically similar case in the Natal Government Railway Power Station at Durban. The remedy adopted was identical with that suggested by the Editors of the Electrical Review. Soon after this had been done the field connection of one of the dynamos (whilst working in multiple with other machines) was broken accidentally by a coolie labourer. The circuit-breaker acted, and no damage occurred to the dynamo, which was running again on the bus-bars 10 minutes after the occurrence.

G. F. A. Norman.

Pietermaritzburg, Natal, S.A.,
August 17th, 1905.

The Value of the I.E.E.

Kindly allow me, though far away, just a small space in your columns on a most important subject, viz., "The Value of the Institution of Electrical Engineers."

I quite agree with "Provincial's" remarks in your issue of June 16th, as although it is 10 years since I joined the Institution, I regret that I cannot say it has been of any service to me even when out of employment, for instance:—When interviewing a prominent consulting engineer in the City I was asked particulars of my technical training after I had shown my testimonials for practical work. I pointed out my City and Guilds of London Certificate for Electrical Engineering, and also mentioned that I was an A.I.E.E. The engineer in question replied with a sneer "what is the use of that?"

In subsequent experience I have found that his remark had something of truth in it.

I know a certain M.I.E.E. who has not the slightest idea of the running of a station, or how to test the insulation resistance of cables, or the testing of plant generally, or the setting of brushes, but he is a good draughtsman. Again, I know a certain Associate here in India who, to my personal knowledge, is quite ignorant of the testing of house and motor installations for insulation resistance or leaks.

I should be glad to see an entrance examination in theoretical, practical and commercial engineering (electrical) substituted for the present mode of admission, viz., of obtaining the signature of a certain number of members; also that each higher grade could only be reached by passing a stiffer examination in the above subject.

If this could be carried out only men of a good sound knowledge of the profession would belong to the Institution, which would then be looked up to as a guarantee of proficiency amongst consulting engineers and municipalities, whereas at the present time it is regarded as simply a farce.

Chief Engineer.

[It should be clearly understood that the "Associate" class is specifically intended for persons associated with electrical engineering, but not necessarily engaged in, or trained in, that profession. The "Associate Member" class is confined to persons coming under the latter heads, and the annual subscription is the same as in the "Associate" class.—Eds. E.R.]

An Overcrowded Profession.

I have read with interest your excellent leading article *re* the above in the current issue of the Electrical Review, and the profession should be indebted to you for bringing the matter forward.

As I have before pointed out in your valuable paper, the fault is that in England we have no recognised system of training. If, as Mr. Browne suggests in his excellent article (see the Electrical Review, July 14th, 1905, page 75), that a fixed course of training should be followed and a certificate awarded before the candidate could call himself an electrical engineer, there would not be 150 applicants for posts at servants' wages.

At the same time it must not be lost sight of that many engineers, those in central stations, for example, will oppose a works and college course, if compulsory, as it would stop the income derived from taking pupils. In past years a man with a greengrocer's shop would expect his son to take up the business after him; now, however, "Horace" must become an electrical engineer, the borough engineer taking him for £30 as a pupil for two years.

Referring to your notes *re* "Qualifications of Italian Engineers," you see the first thing asked for is a Diploma of Civil Engineer and Architect. In the advertisements in the Electrical Review do they ever ask for the Diploma of the I.E.E.? Compare the clear way in which this advertisement is written with the nonsense which appears in similar advertisements in the engineering papers.

I would like to see it enforced that every electrical engineer should spend three years in the works and one or two years at college, the premiums being fixed for all alike, there being three exams. to pass, preliminary, intermediate and final, and it would only be after the final that the candidate could call himself an electrical engineer. The various degrees of student, associate and associate member, at the Institution should be done away with, and, as in France, the final examination should enable the candidate to become a M.I.E.E. if he wished. For reasons already stated, I doubt if the present system will be changed.

Common Sense.

Electricity is year by year entering more and more into our everyday life—its rapid growth, the brilliance of its triumphs, and its future possibilities, are now almost as well known to the man in the street as to the specialist. What wonder, then, that paterfamilias turns hopefully towards it when seeking a career for his boys.

There is, unfortunately, a large number of persons who expect by supplementing an extremely poor general education

by a couple of years at a technical school to qualify themselves for responsible positions as electrical engineers. These so-called "technically-trained men" have naturally made manufacturers and engineers somewhat shy of men so styled, and further, as they find it difficult to rise in their profession, they help to swell the chorus of complaint as to overcrowding.

The great obstacle to successful technical training in this country is the low standard of general education which prevails in our public and secondary schools—at any rate, amongst those who are looking to taking up engineering or industrial work in the future. This is largely due to the best men being secured for classical work, partly because the modern side is still often regarded as a sort of refuge for those who fail in classics, and further, on account of the extensive system of close or tied scholarships existing between the public schools and certain colleges of the older universities which are largely classical in character. We want the best men we can produce for our engineering industries, and unless it is generally understood that such men are sought for by our manufacturers, and valued by them, they will continue to find an outlet for their energies in other directions.

It is the business of the technical schools to turn out men with well-trained minds not only skilled in technical matters, but resourceful, original and with power of initiation. It is absolutely useless to take a poorly prepared lad of 15, and expect to make a "technically-trained man" of him in a couple of years.

A recently issued return showing the number of students taking a third or fourth year's course in technical work in this country shows that their number is lamentably small, compared with those undertaking work of a similar character in the States and in Germany.

We must recognise that a successful training in electrical engineering will depend upon a thoroughly sound, general education as a basis followed by two or three years in works and three or four years in a technical college or *vice versâ*. The period of training is long and necessarily expensive, if not in fees, at least in maintenance, and the initial remuneration small. A well-trained capable man should, however, be able to command £150 per annum at 25 years of age, and from £250 to £500 at 35 with a prospect of one of the plums of the profession later on.

With regard to the manufacturers, if they all took the same interest in their apprentices as do the British Westinghouse Co., there would be nothing to complain of, but the iniquitous premium system still flourishes, and many firms are adverse to, or even afraid of, taking on a well-trained man.

Things are, however, changing for the better; within the last few years many old works have been remodelled and new and progressive firms have sprung up, and the demand for well-trained men is certainly increasing.

Although examinations are to be avoided where possible, we are badly in need of some recognised standard of training in electrical engineering which would have a recognised value for the public.

We now have scattered over the country a large number of technical schools, some large, but mostly small. The larger institutions are strong enough to stand by themselves, or are affiliated to one of the newer Universities, but the work of the smaller schools is not co-ordinated, and varies greatly in character and quality, and the general public are quite unable to attach a definite value to their certificates or curricula, or to the "technically-trained men" that they produce.

Has not the time come for our Institution to follow the lead of the Civils by instituting an examinational test for their students and associate members? These examinations would at least furnish a hall-mark whereby we could at sight distinguish between men who had passed through the prescribed training and those who had not.

Surely we can do for our profession what the Medical Council has so successfully done for the education of medical men, and then we shall be able to attach a more definite, and I hope also an enhanced, value to the expression "the technically-trained man."

Alfred Schwartz.

Manchester, *September 11th*, 1905.

Coal Deposits v. Water-power.

With reference to your editorial under the above heading, in your issue of September 8th, will you permit me to say that I think you have raised a most seasonable discussion.

I have remarked on many occasions, and still contend, that there is no more danger involved in consequence of the use of overhead mains for high voltages than in the ordinary overhead trolley lines with which the authorities and the public are now so familiar.

I mentioned at the time of the discussion on Mr. Addenbrooke's paper, that in the number of high tension overhead transmission lines which I have carried out in different parts of Europe, I do not know of one single case where an accident to life or property has occurred in consequence of a break in an overhead wire. I make a point of keeping in touch with the station engineers now in charge of the plants with which I have been connected, and I have never received any information which has shown that any danger was involved by using bare overhead conductors.

If 25 to 30,000-volt mains, properly supported on poles, through densely populated districts, can be used on the Continent of Europe, I fail to see any reason why they should not be used in Great Britain. Their extensive use has, up to this moment, only been prevented in consequence of the antiquated ideas held in certain quarters. Also it is certain that a well-designed overhead line is as free from breakdowns as the best underground conductor, and with modern protectors, the probability of damage from lightning is extremely small. Further, there is less trouble from "surges" due to distributed capacity and inductance of high pressure lines.

As I have said before, I think this is a matter which is of such importance to the electrical profession as a whole, that it should be the business of the I.E.E. to devote all its influence and energies to combat the prejudice which prevails against the bare overhead conductor. There is no doubt that if this prejudice were overcome, it would ensure a decided improvement in the prospects of electric power transmission, *e.g.*, that more electrical work would be carried out, more engineers and more men would be required, and this is, I believe, one of the remedies for which you ask in your leader on "An Overcrowded Profession" in your issue of the same date.

I have, unfortunately, lately had many proofs of the correctness of this assertion.

If we are to reach the ideal condition of house-industry as mentioned by Colonel Crompton in his James Forrest Lecture, we shall certainly want overhead mains in place of underground conductors.

Arthur J. Bloemendal.

London, *September 11th*, 1905.

[In view of the interest and importance of the question of overhead mains, we are making inquiries as to the present state of the matter. It should be borne in mind that the attitude of the Board of Trade on this question is that of the open mind, and that several high pressure overhead transmission systems have been sanctioned by the Board already.—Eds. E.R.]

Earth-Detecting Instrument.

In the Electrical Review of the 8th inst., Mr. Edgcumbe makes it quite clear why there is no reading on the normal point.

As the Special Rules now in force in connection with Electricity in Mines state that "the leakage current shall, so far as is reasonably practicable, not exceed one-thousandth of the maximum current," I want to find, in a plant such as has been described, what allowance ought to be made from the capacity current, in order to have indicated daily the leakage current; without this information the leakage detector is really of no practical use as a measuring instrument. An ordinary incandescent lamp can be so placed as to indicate leakage, but the difficulty is to know to what extent, so as to keep within the meaning of the Special Rules. If Mr. Edgcumbe or any of your expert readers can show how to get over the seeming difficulty of making the proper allowance when taking the readings, it will be the means of making the detecting instrument of use.

E

	Tests on Main A and B together.		Tests on Main A only.		Tests on Main B only.	
	Standing.	Running.	Standing.	Running.	Standing.	Running.
Volts	440	440	440	440	440	440
Amperes	nil	210	nil	120	nil	Instrument not calibrated finely enough to give a reading
Length and Size of Cables in use—						
Length of cable with current on ...	1,755 yds. ·35 in. 3-core 107 yds. ·15 in. „ 417 yds. ·06 in. „ 4,077 yds. ·01 in. „ 125 yds. ·20 in. „ 56 yds. ·125 in. „ 90 yds. ·062 in. „		1,755 yds. ·35 in. 3-core 107 yds. ·15 in. „ 417 yds. ·06 in. „ 4,077 yds. ·01 in. „		125 yds. ·20 in. 3-core 56 yds. ·125 in. „ 90 yds. ·062 in. „	
Total length	6,627 yds.		6,356 yds.		271 yds.	
Earth detecting instrument readings—						
Normal reading	nil	nil	nil	nil	nil	nil
Phase A (milliamperes) ...	33	33	32·75	33	6	15
„ B „ ...	33	33	33	33	8	15
„ C „ ...	33·75	34	32·75	33·5	6	16
Insulation tests—						
Phase A (ohms)	Has not been tried.		172,131		897,436	
„ B „			177,966		833,333	
„ C „			177,966		1,093,750	

Mr. Edgcumbe is quite right; when the trials were made the instrument was cross-connected.

As suggested, I give herewith the insulation measurements on circuits A and B separately. The foregoing tabulated statement shows the reading on the leakage detector, also the conditions under which they were taken, together with the insulation readings taken by a direct-current instrument.

Mining Engineer.

Consulting Engineers and their Specifications.

I have noticed your correspondent's letter headed "Consulting Engineers and their Specifications." As he obviously refers to a consulting engineer in Bristol, I should be much obliged if he would inform me whether he is alluding to work which has passed through my office, as, if so, I shall ask you to allow me to contradict the whole of the statements as far as they refer to the latter part of the letter. I feel it necessary to do this, as a number of my friends have drawn my attention to the letter. I shall esteem it a favour if you will include this in your next issue.

Herbert T. Sully.

Bristol, *September 11th*, 1905.

Evaporative Trials of Bennis Plant.

We have read with some astonishment your comments on our letter of last week on the above subject. Although the word "impossible" occurs no less than seven times in one column, we have failed to discover any valid argument in support of your contention that it must be applied to our figures.

With regard to the mistake in your original note respecting the steam temperature, you claim "the credit of having given Mr. Bennis the benefit of 25°." We do not ask for, nor desire, the support of arithmetical blunders to bolster up our case. We prefer to stand or fall by the facts.

You next, relying upon Dulong's formula, insist on reducing the 12,600 B.TH.U., which was found to be the heating value of 1 lb. of coal, to 12,170. This and other formulæ for calculating the heating value of a coal from the chemical analysis are useful for a rough estimate where nothing better can be obtained, but we have never before seen the formulæ set up to correct a calorimeter determination. In the *Minutes of Proceedings* of the Institution of Civil Engineers, Vol. 102, p. 292, there is printed a paper by Bryan Donkin and John Holliday on fuel testing, in which four formulæ are quoted for calculating the heating value, and an example is given of their application in which these formulæ give results which differ among themselves by 1,468 B.TH.U. per lb., and Dulong's formula, which gives the lowest results, shows 741 B.TH.U. per lb. less than the true value by experiment. Again, in the same *Proceedings*, Vol. 108, p. 459, in the abstract of a paper by Scheurer-Kestner and Meunier-Dollfus on "New Researches on the Calorific Value of Coal," it is stated, "The authors arrive at the conclusion that it is impossible to ascertain correctly the calorific value of any given coal by calculation, and that it should be tested in a good calorimeter." So much for your assertion that "the calorific capacity per pound of coal will be at most about . . . . . 12,170 B.TH.U. as compared with the 12,600 B.TH.U. stated by Messrs. Bennis."

With regard to the question of the amount of air passed through the fires per pound of coal, it may be useful to point out that, with coal of the composition stated, 30 per cent. excess of air gives the following volumetric composition for the waste gases (neglecting the water vapour, which is not taken into account in the ordinary gas-testing apparatus, such as the Orsat):—

CO_2	13·38	per cent.
Oxygen	4·93	„
Nitrogen	81·69	„

How can any competent person say of such a waste gas analysis that "everyone should know it was not obtained." We are asked for proof that this 30 per cent. was the true quantity. We have no direct proof, as the gases were not analysed during the test in question. We stated in our letter that "we find 30 per cent. ample," *and this is so.* With a boiler in good condition, sound brickwork, and correct handling of the machine it is by no means unusual to obtain from 14·5 to 16 per cent. of CO_2 in the waste gases, and such results are obtained in everyday practice in many places where this important point is properly attended to.

We really cannot enter into a discussion of the possible reasons why tests made in different places, on different boilers, with different coal, different conditions of draught, &c., yield different results. Such a question is absolutely irrelevant to the point at issue. The fact that one test gave an efficiency of 57·3 per cent. is *in itself* no proof that another test did not give an efficiency of 88·1 per cent. The converse proposition could be put forward just as logically, or, rather, just as illogically. Each statement must be judged solely on its own merits.

The test at Messrs. Firth & Sons' works was not made in order to obtain a balance of heat generated, utilised, sent up chimney, radiated, &c. It was made solely to establish, to the satisfaction of that firm, the *relative* efficiency and cost of evaporation at their works by hand firing and by our machine stoker. Had a heat balance been the object in view, all necessary observations of flue gas temperature and analysis, &c., would have been made. When, however, the results are stated to be physically impossible, we are entitled to fill up the gaps by figures based on our known practice as ascertained by tests where a heat balance *was* the primary

object. The figures as given indicate the following distribution of the heat from 1 lb. of coal :—

By evaporation	... ...	11,109 B.TH.U.
„ waste gases	... ...	1,138
„ radiation, &c.	... ...	353
		12,600

Since 1,246 lb. of coal were consumed per hour, the item "radiation, &c." amounts to practically 440,000 B.TH.U. per hour. We are asked what is our estimate of the loss by radiation. We have not made any experiments to determine this, and are not aware that any very reliable experiments have been made. In Hutton's "Steam Boiler Construction," 1898 edition, p. 15, a rule is given as follows :—

Radiation per square foot covered surface per hour $= 1{\cdot}2\ (T - t)$ B.TH.U., where T and t are the temperatures Fahrenheit of the steam in the boiler and of the atmosphere, respectively.

This formula would give a loss of 330 B.TH.U. per square foot per hour during our test. The formula is stated to be deduced from experiments, but whose experiments we do not know. Having been asked for an estimate, we quote it for what it may be worth.

You refer to "the already exploded efficiency of 84·9 per cent. at Sheffield." This result has not been "exploded." Facts are stubborn things and are not likely to collapse at the first blast of a trumpet, even when blown by an irresponsible and anonymous scribbler.

We shall not respond to your invitation to "show that Regnault and Rankine and Joule are wrong," for we are quite content to accept their teachings and to have whatever figures we publish fairly interpreted and judged in accordance with the results of their researches. But mere claptrap neither reflects credit on the writer, nor harms him who is made the butt thereof.

For **Ed. Bennis & Co., Ltd.,**
ALFRED W. BENNIS.

Bolton, *September 11th*, 1905.

[We did *not* employ Dulong's formulæ, but allowed for the fact that the production of steam in combustion prevents the realisation of its latent heat. Even if 12,600 B.TH.U. be accepted, we fail to see how Messrs. Bennis make out their case. They only allow 3 per cent. for radiation loss.

It is really hardly worth while discussing the matter further. The test was not an independent one, there was no gas analysis made, so that Messrs. Bennis have no right to claim what they do in face of its unprecedented figure, and the whole of the boiler experts in the kingdom cannot, we venture to say, be called on to express an opinion of the probability of the correctness of 88·1 per cent. Even if Messrs. Bennis's figures as to calorific capacity were right, they have shown an impossible result for the high rate of working. As regards the Sheffield test, we think if Messrs. Bennis will make inquiries they will find at least that these figures were regarded as exploded by the letter which appeared in our columns signed "Calories," and written by an expert who, perhaps it may please Messrs. Bennis to know, was not the writer of our present note. We certainly have judged the statement and claim of 88·1 per cent. efficiency as requested, to wit, on its merits. By the way, when getting 14 to 16 per cent. of CO_2, do Messrs. Bennis get *no* CO ?—EDS. E.R.]

Mr. Bennis admits that he has no record of the temperature of the flue gases ; no record of the calorific value of the fuel used, the admittedly conjectural value attributed cannot be accepted ; no record of air supplied, his statement of air supply is evidently mere assumption. Has Mr. Bennis any record of analyses of the gases at the dampers, or elsewhere ?

Has he any record giving the calorific value of the steam produced ? From the duty given, viz., 14,925 lb. steam, from and at 212° F., per hour from a Lancashire boiler 30 ft. long × 8 ft. diameter, I should judge the steam to be "wet," *very* "wet," probably "soup," and this might account for much of the so-called efficiency and duty.

Were not the gases after leaving the boiler utilised to heat he feed water in the "economisers ?"

Mr. Bennis assumes a temperature at the dampers of 400° F. ; would not 650° F. be nearer the mark ?

I note the water was measured by meter, not weighed.

I would humbly suggest to Mr. Bennis that he consult those "experts" at whom he girds in such bitterness of spirit ; they would willingly assist him to make reliable tests and to issue acceptable reports, whereby he would gain much in moral and material benefit.

S. U. R. Chauffeur.

Some Arithmetical Questions for Mr. Byng.

Referring to the last paragraph of Mr. Byng's letter on the Fiscal Policy in your last issue, may I assure Mr. Byng that "the most important man in the realm" will never be recruited from the ranks of those who, years ago, and with the most altruistic motives, decided to forgo the pleasures and advantages of life under protection and departed to a foreign country where life, owing to the out-of-date methods in use in the commercial world, could at best be only a severe battle with poverty and possible starvation.

May I say, as an Englishman, that I am getting very tired of Mr. Byng and his eternal complaints against a system which at the least has provided him with the proverbial crust.

If he is so dissatisfied with our fiscal arrangements, why on earth did he come at all, and especially why doesn't he return to a land where the principles he admires so much have been adopted with such conspicuous success ?

A Free Trade Englishman.

Having stated that arithmetically the question between Mr. Byng and myself was for the moment closed, I have some compunction in submitting to the editorial discretion a few words in reply to Mr. Byng's letter of September 5th.

My remarks anent conflicting interests, my earlier query as to the practical means whereby an increased export trade in electrical wares was to be done, say, with France, are ignored. Of this I do not complain, but I do and still believe that I was justified in protesting against the dictum that the settlement of the unemployed question should rest solely with the manufacturers.

I could give Mr. Byng many reasons, not connected with "more Socialism and more charity and more rates," for considering other remedies for the present distress. Many of these would be of an ethical and sociological order. Others would be economic. In the last class would lie the phenomenon of trade cycles. If any of your readers will study these in all their aspects, instead of viewing them along the vista of a rut of self—rather than national—interest, they will find that so far as engineering industries go, employment is not "as bad as ever." It has often been infinitely worse, and, above all, that engineering imports have a general downward tendency when the rate of unemployment rises.

I am in no way concerned with a defence of Socialism, nor, I should imagine, is Mr. Byng. As he is so preoccupied with the golden vista which his pet panacea offers to his expectant vision, I hope he will not be greatly shocked if I remind him that it is in protectionist Germany that Socialism has attained its greatest power as a political force. There, with a paternal government striving hard to induce the agrarians and the manufacturers to live at peace with each other and with the happy artizan, the leading cities of the Empire all unite in sending social democrats to the Reichstag. It is not inconceivable that the day may come when London, Liverpool, Manchester, Bradford and Sheffield will send solid blocks of avowedly socialist members to Westminster. If it does come, it will only be due to the Protectionist school, to the effect of its almost obvious fallacies and golden promises on skilled artizans (unemployed by the G.E.C.) and on the thoughtless readers of an ephemeral daily Press.

Finally, the statistician, endeavouring to be honest, really does heed what the manufacturer has to say. He does, however, endeavour to put it in its proper relation to other facts concerning dependent industries, not necessarily within that particular manufacturer's cognisance. But for doing

this, and asking for proof of the basis of the prophecies of impending doom, well, all the lamentations of a modern Jeremiah are to be heaped upon his "otherwise well-meaning" head, and recited to the stiff-necked majority who listen to the statistician.

W. Pollard Digby.

London, W.C., *September 11th*, 1905.

I have noted with no little interest Mr. Byng's attempt to convince some of your readers to his way of thinking, and it is only by exercising the greatest possible self-restraint that I have been able to refrain from coming earlier to his assistance. There appear to be so many side lines leading off the main track, that it is next to impossible to keep one's attention riveted to the main principles involved, and almost everyone on both sides indulges in a certain amount of exaggerated bunkum. If Mr. Byng's contentions are not convincing, I trust I may be more successful by putting his contentions in another form. As, for instance, what could be more convincing than that something is wrong when our last Board of Trade returns show our year's exports and imports almost to have been a record, whilst we know at the same time we have during the same period almost had a record depression, excessive competition, and a general all-round lack of employment. Can this condition of affairs be explained in any other way than that we have been exchanging in far too great a proportion our exports of manufactured goods for imports of a non-life supporting nature? For instance, if we exchange one hundred million value of our manufactured goods, such as, say, dynamos, knives, cotton goods, &c., for other people's motors, scissors, boots, &c., the result is of absolutely no supporting value for the British working man. On the other hand, if we but exchange one million of the same goods for other people's corn, beef and mutton, the result is support for thousands of British working men and their families. If we are content to go on exchanging our knives, &c., in ever-increasing ratio for other people's scissors, &c., let us by all means stick to Free Trade and export our population instead of the result of their labours. On the other hand, if we desire to provide the means of support for our existing population and its natural increase, it is absolutely necessary to give imports of a life supporting nature preference over imports of a non-life sustaining nature. This should be evident even to the most obtuse. If any free trader will come forward and say how we are to give preference to imports of a life supporting nature without placing an import tax on imported goods of a non-life supporting nature, those who are in favour of fiscal reform would be glad to give him an attentive hearing. If free traders would study this aspect of the case instead of dwelling so much on manufacturers' presupposed inflation of profits, the word Protection would have its true meaning, viz., protecting the food supply of the British working man.

H. W. Wilson.

Stowmarket, *September 12th*, 1905.

The Statter Time-Limit Appliance.

I regret that I must fall foul of the description of my new time-limit appliance, as contained in your last issue. I feel that it is particularly ungracious in me to carp at a description obviously conscientiously prepared from a close inspection at the late traction exhibition; but in the interests of science there is no help for it, so here goes:—

1. The time-limit device is in no sense a "dash-pot." That is exactly what it is not. Its action depends upon the adherence of two plane surfaces to one another. If these surfaces were true planes—no oil would be needed—but as such things are impossible (anyhow commercially impossible), I need to use a film of oil between the surfaces. But this does not make the appliance a dash-pot!

The great advantage of my patent is that there is no back-lash; the surfaces adhere and resist the pull of the trigger-striking armature *completely*, until by the force of the pull the planes become separated by ever so small a distance. Then the resistance to the pull suddenly becomes *nil*, and the trigger-striking armature darts at the trigger.

The inverse time element owes its existence to the fact that the harder you try to force the planes apart the sooner does a small quantity of oil get between them, and then all resistance vanishes. Obviously, mechanical skill can arrange those semi-plane surfaces, so that the time shall be what the conditions of a particular case require; but now I am getting beyond a mere correction. What I wish to point out is that my attachment stops *all movement* of the trigger-striking armature until, at a given moment, it allows free unhampered movement. Just the opposite to a dash-pot, which does not begin to act at all until there has been movement.

2. The illustration of the battery regulator shows a Thury regulator. The regulator shown was different in form. Scientifically, the two are alike, but I do not like to see my name under a block of a Thury regulator.

3. The illustration of the blow-out fuse is, as your parenthesis noted, a wicked one; in addition to the point you called attention to, even the clamping screws for the fuse and those for the cable socket are not correctly illustrated.

J. G. Statter.

Birmingham, *September 11th*, 1905.

[As regards the last two corrections, we can only express our regret for the unintentional errors of description. We are unable, however, to agree with Mr. Statter that "dash-pot action" does not occur in his extremely ingenious time-limit device. The "dash-pot" principle depends upon the viscous flow of a liquid or gas between closely apposed surfaces, and whether the surfaces are flat or cylindrical makes no difference to the essential principle. Mr. Statter admits in his letter that the presence of oil is necessary, and that the speed of action depends upon the force exerted. "The harder you try to force the planes apart, the sooner does a small quantity of oil get between them." Directly the planes are separated, the oil can enter freely, and the resistance vanishes.

The initial resistance, we take it, is that due to the weight of the iron core; directly this is overcome, the time limit action commences, and even the smallest pull in excess of the weight of the core will—if maintained long enough—eventually open the circuit-breaker. This is true "dash-pot action," but without the drawbacks of the ordinary dash-pot.—Eds. E.R.]

Inspection and Testing of Tramway Overhead Equipment.

As I am one of the linemen using the testing apparatus described by Mr. Tweedy, I would like to point out to Mr. S. Worthington, or any others interested, that its use does not interfere with the wagon-driver's duties, as Mr. Worthington suggests. The driver walks at the horse's head and carries a brass-shod walking stick, with which he touches the rail under each span. This is surely quicker and easier for both the driver and horse, than getting the wagon in to every pole, with the gutter, perhaps, sloping like the roof of a house, or the poles planted back on the pavement. My driver certainly does not regret the change.

I have used different methods of testing on different lines, and the one I now use is certainly much the quickest and best of them. The fact that both insulations are tested without moving the wagon, and with practically the same ease as when testing only one, should, I think, appeal to most linemen. Moreover, by Mr. Tweedy's method, the hanger bolts are tested with the rail itself as an earth. By going to the pole, there is the paint on it, and also the more or less high resistance of the earth surrounding the pole, to contend with—unless it is bonded to the rail.

I can't understand why Mr. Worthington is not allowed to flash the wire. If he used a heavy enough fuse I daresay it would be apt to open the station breaker when it blew, and it certainly would not be good for the trolley wire or his own eyes. I use very fine tin wire that does no harm to anything when it blows. A heavy fuse, that carries, say, 5 or 10 or more amperes, would be of little use, for if a hanger bolt was broken down enough to allow only 4 amperes to pass it would not blow the fuse, but if the secondary insulation also failed the hanger would burn out all right.

Mr. Pott's plan for testing is interesting, but I think

it would be more of a luxury than a necessity. The lineman would, of course, still have to do his ordinary inspection tour. If the testing is done in conjunction with this inspection, it takes very little time indeed—at least by the method I now use—and it is done with a degree of certainty that, I think, would hardly be possible by Mr. Pott's method, at junctions especially, or over a system using different types of suspension.

I might add that my testing set is always hanging ready on the wagon, and is useful at other times besides inspections.

Before starting on a job at night I can tell at once, if I have any doubt whether the "juice" is off. Or if I am about to use a globe-strain or a brooklyn that looks none too good, I can test it in a twinkling.

H. Dudgeon, *lineman,*
Dudley, Stourbridge and District Electric Traction Co., Ltd.

Stourbridge, *September 12th*, 1905.

I must say, in answer to Mr. Worthington's letter of the 3rd inst., something which I was careful not to say in my last.

If two 250-volt lamps in series are used for testing trolley-wire insulators they are unlikely to burn out when a faulty insulator throws some pressure under 500 volts on to them—I don't know many lines that could do more—therefore, a fuse to protect these lamps is superfluous, as well as objectionable, for the reasons given previously.

To use a fuse merely for the sake of protecting the lamps from short-circuits arising in the holders or connecting wires is to gain a small and remote advantage at the expense of others more important.

The fuse alone serves all the purposes of the test in the simplest way, while the addition of lamps offers no advantage.

Mr. Pott's letter is particularly interesting to me, as I worked out, some time ago, a system which must be almost identical with his, but decided not to employ it because of the openings for carelessness and error which seemed to attach to it. A daily test of every insulator is not to be despised, but a weekly test carried out scrupulously, and accompanied by visual inspection, is quite good enough for any line on which the insulators are of good quality. Of course, one has heard of lines on which the insulators were so treacherous that an hourly test would have been an insufficient safeguard.

Robert N. Tweedy.

Stourbridge, *September 9th*, 1905.

BUSINESS NOTES.

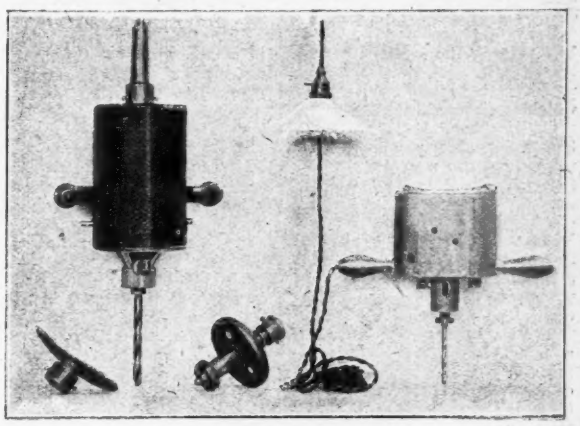
Brazil.—The recent reports regarding the sale of certain electrical undertakings in Brazil are now confirmed by the announcement that the principal assets of the Brazilian Electricity Co., of Berlin, have been disposed of. These are the telephone installation at Rio de Janiero and the Villa Isabel Tramway in the same city, which have been taken over, according to the Berlin *Tageblatt*, by the Brazilian Securities Co. It is stated that the purchase price yields a considerable profit to the Berlin company as compared with the book value of the undertakings.—*Financial Times.*

Australia.—The Australian Customs authorities have lately given a decision to the effect that "cords, telephone, with metal switch blocks attached," are to be classified as "machinery and apparatus n.e.i. electrical," the duty being 12½ *ad valorem.*

Imports of Foreign Electrical Apparatus.—It is noteworthy that, while the importation of foreign electrical machinery into this country is declining, that of foreign electrical goods and apparatus is showing an upward tendency. Thus the value of such imports during August last is returned at £77,704, as against only £67,766 in the same month of last year. For the eight months ending with August the returns show a total of £614,813, which contrasts with £502,265 in the corresponding period of 1904.

South Lancashire Tramways: Sale.—The goodwill and undertaking, &c., of the South Lancashire Electric Traction and Power Co., Ltd., are to be sold by private tender. Full particulars appear in our advertisements to-day.

Crossley's Electric Drill.—A neat little electric drill has recently been put upon the market by Messrs. Crossley & Co., of Johnstone, N.B., and was shown in operation at the exhibition recently held in connection with the Yorkshire electric power scheme, by Mr. C. W. B. Crossley, of Exchange Buildings, Manchester. The drill is made in two sizes; the lighter one (No. 1), weighing 15 lb., is extremely portable, and will drill up to ⅝ in. diameter in steel; the heavier one (No. 2), of 25 lb. weight, although also adaptable as a breast drill, is provided with accessories, which render it useful in a variety of ways; it is designed to drill up to ¾ in. diameter in steel. Thus, the latter drill can be used suspended from a bar, for which a feeding screw is provided as shown in the illustration, or it can be fitted with a taper shank, as will be seen, and used as an accessory to a large radial drilling machine for the purpose of drilling a large number of small holes,



Crossley's Electric Drill.

an operation which is accomplished in less time and at less cost of power than with the large machine. By means of a wire brush attachment, the No. 2 drill can be adapted for cleaning castings; or for grinding or polishing, by the attachment of an emery wheel or polishing disk.

In both drills an aluminium case contributes to ensuring light weight; the motors have slot-wound armatures and commutation is effected by means of carbon brushes, the pressure on which is adjusted by a neat spring control. The magnet windings are compounded, and give a speed variation of nearly 50 per cent. from "no load" to "full load." The drill spindle runs in long gun-metal bearings, and is provided with a ball thrust bearing; the two sizes are bored for Nos. 1 and 2 standard taper shanks respectively; the gears are all cut from solid steel blanks and the plunger type of make-and-break switch, fixed within finger reach of the operator, provides a convenient and effective means of starting and stopping the device.

The machines can be built for any voltage up to 250 D.C., and can be adapted for drilling wood, stone or slate; the workmanship appeared all that could be desired, and the makers guarantee the drill for a period of six months.

Manchuria.—The U.S. Consul at Niu-Chwang states that very little modern machinery of any kind, aside from that used in connection with railway building, has been brought into this part of China. He recommends manufacturers to send samples and illustrated price lists, and says that the special agents sent out by some firms have achieved good results.

Catalogues and Lists.—Messrs. J. Marx & Co., Chiswell House, Finsbury Pavement, E.C.—Catalogue (60 pp.) of numerous types of "Schwade" "Automat" pumps for boiler feed and innumerable other purposes. The catalogue is fully illustrated, and tabulated data are given respecting every type shown. The Schwade Works give employment to about 1,000 hands.

The Westminster Engineering Co., Ltd., Victoria Road, Willesden Junction, N.W.—Catalogue just published, giving full information relating to their dynamos, motors and arc lamps; specification and many tabulated particulars of sizes, dimensions, prices, &c., appear regarding the two former sections of the company's manufactures, but the bulk of the list is devoted to the third section—arc lamps. Here there are various types of enclosed and open lamps, also those for photographic, photo-printing and enlarging, overhead suspension gear for photographic lamps, and movable tripod stands for photo-printing lamps are described, a good batch of testimonials from users following. Art paper, good arrangement and excellent printing have combined to produce an extremely neat catalogue.

Messrs. Siemens Bros. & Co., Ltd., Westminster.—Price list 5B, dealing with switchboard instruments and accessories. This catalogue of 50 pages, is divided into five parts, as follows:—Electro-magnetic Instruments, Moving-coil Instruments, Ferraris Instruments, Instrument Transformers, and various special instruments and accessories. Each type of instrument is made in a large variety of sub-types, suitable for all sorts of purposes. Specifications and dimension drawings are shown for all instruments. The electro-magnetic instruments are intended for general switchboard use; they are practically dead-beat. The moving-coil instruments,

which are, of course, intended for use with continuous current only include types with flush cases and water-tight cases, edgewise dials, and specially large circular dials. A large range of shunts for use with the ammeters is also listed. Other special instruments of the moving-coil type shown are combined ammeters and voltmeters for searchlights and automobiles, and wattmeters built on the dynamometer principle. Ferraris instruments, for alternating currents only, are built on the well-known rotary field principle, and ammeters, voltmeters and wattmeters are listed in a large number of sub-types, as with the moving-coil instruments. A special feature is made of wattmeters for three-phase currents with branches unequally loaded. A special type of universal station instrument is shown with dial 21 in. in diameter, for reading station volts, amperes and kilowatts. Current and voltage transformers are listed in a variety of types for working voltages from 1,000 to 50,000 volts. The special instruments comprise current directing indicators, earth indicators, ohmmeters, voltage and power relays, and safety relays for breakages of three-phase overhead lines. We have also received a copy of price sheet No. 15, describing the Tantalum electric glow lamp.

Portable Accumulators, Ltd., 210, Shaftesbury Avenue, W.C.—Price list (neatly illustrated) of single cells and complete batteries, in glass, ebonite, and celluloid, fitted with low discharge plates (pasted type). Particulars of types, capacities, dimensions, weights and prices, are conveniently arranged.

Generators, Ltd., 77-78, Trevelyan Buildings, Corporation Street, Manchester.—Several new leaflets brought together in a taking red cover which allows of the addition of later lists as issued. Particulars appear of controller fingers for different makers' controllers, commutators for standard tramway motors of several makes, Benjamin's patent wireless cluster fittings, and Vitae carbon brushes for car motors. The lists are being circulated among tramway managers and engineers with prices filled in according to the equipment in use on each individual system. The prices are of necessity subject to variation from time to time, dependent upon the course of the copper market.

The Electrical Co., Ltd., London.—Circular No. 171 showing a new type of gear wheels with renewable rims, for tramway motors; No. 170 showing commutators for tramway motors and contact fingers for tramway controllers; 179 and 180 illustrating their lifting magnets for transporting iron and steel castings, rails, &c.

Messrs. Veritys, Ltd., Manchester.—Catalogue No. 514 giving full particulars of their various enclosed and open arc lamps. New designs and revised prices are set out in readiness for the 1905-6 season. The illustrations show single and double enclosure lamps, and single enclosure ornamental designs, made under the Aston-Worsley patents, and the "Aston" open-type lamps appear with and without globes. The enclosed lamps have only been on the market one season, but we understand that they have had a very successful run. It is interesting to mention that 188 of these lamps have been selected for the owners of "Olympia" for the permanent lighting, and they will do service for the lighting of the Electrical Exhibition which opens on 25th inst. Messrs. Verity have just completed the street lighting contract at Buxton. The list sets out prices in detail, and gives code words, shipping and other useful information. Globes and reflectors, substitutional resistances and winches, are described in the list, and there is also an account of the "Aston-Worsley" automatic clutch and contact, to which we shall refer in a later issue.

The Simplex Steel Conduit Co., Ltd., Birmingham.—New price sheet either for hanging up in offices or for folding for the pocket. It gives in a condensed form most of the prices of conduits and fittings appearing in the company's 1905 catalogue.

Mr. A. P. Lundberg, Liverpool Road, N.—Two further advance proofs of new lists. One shows a large number of illustrations of the patent "Duplex" tumbler switch of flush and surface types, and with locked type covers, also many useful diagrams showing various adaptations of these switches, such as for controlling a two-filament lamp, producing dim light, tramcar lighting, as a change-over switch, for ignition cells, intermediate wiring, and arc lamp control. The other list particularises armoured plugs, ebonite disk, twin and triple socket and "Magnum" special pattern two-pin plug, also pivot switches with locked covers. The lists are conveniently set out.

Electrical Enterprise in Japan.—Following our article of last week on this subject, we now give a few facts of interest from an article by Mr. T. Hirokawa appearing in the *Engineer*, of Chicago, to hand by this week's mail. The writer says that electrical enterprises are not behind other industries in Japan. Almost every city of over 10,000 population has electric lights and several have street railways. As the country is mountainous throughout, there is abundance of water-power and at present over 30 per cent. of the electric energy used is furnished from this source. The land is also rich in coal mines, so that cheap electric power is a blessing for which all can hope. Among enterprises now under way is the Tokyo Electric Light Co., which is to build a new 20,000-h.p. plant and transmit energy for 50 miles to the city; the Tokyo Electric Power, which is to furnish 43,600 h.p., the first installation being of 24,000; the Kyoto municipal electric works of 2,400 h.p. This is run by the power from the canal to Lake Biwa, which was built in 1885 to furnish water to the old capital. The canal is some 7 miles long including 2·1 miles of tunnels. Kyoto Electric Light Co. has, at present, its own hydraulic power station of 350 h.p., which is soon to be increased to 1,000. In Osaka, the largest commercial city of Japan, the Osaka Electric Light Co. has steam-driven plants, from which it supplies light and power. The smoke problem is present, as hundreds of factory chimneys are darkening the skies, but the Uji River Hydro-Electric Power Co. is planning to send to the city 40,000 h.p. from less than 20 miles away. The company has had some difficulty in raising the 5 million dollars of capital needed, but the power would be taken up in no time, and it is expected that, with the close of the war, the work will soon be commenced. The River Uji is the only outlet of Lake Biwa. In Hakkaido, Kyushu, Formosa, and many other places, works are under construction by either public or private activity. Mr. Hirokawa wrote before peace had come, and he added:—"As soon as the war is ended there will be great activity in the development of power stations, especially of water powers."

The *India-rubber World* for August 1st had another article on the rubber factories of Japan, in which it is stated that from the beginning the insulated wire industry has formed an important branch of the rubber industry in Japan. "The people of that country were early in appreciating the advantages of the industrial uses of electricity, and the domestic manufacture of wire for electrical transmission has acquired considerable dimensions. Hand in hand with this development has been the progress in insulating wire, including the employment of rubber. The Yokohama Electric Wire Manufacturing Co. have perhaps the largest capacity in the line of rubber insulation. Of late their factory has been undergoing enlargement, and their rubber insulation department has been placed in charge of an expert imported from the United States. The Fujikura Insulated Wire and Rubber Co., Tokio, likewise has been growing of late, including the installation of machinery during the past year, which has doubled the capacity of the works—now almost equal to that of the Yokohama Co. The size of the works is indicated in part by the fact that the new engine and boilers are of 100 h.p. The work of this company, by the way, is no longer confined to wire insulation, but embraces the output of various other products of rubber. The factory was established in 1884 by Zenpachi Fujikura, who, at his death in 1901, left it on a profitable basis."

In our references last week to American electrical firms and Japan trade we should have reminded our readers that about 12 months ago Mr. Y. Shinto, B.Sc., of Tokio, made a tour through New York and other parts of America, obtaining data for an exhaustive report on electrical matters, to be submitted to the Japanese Government. This was followed by the statement two or three months ago, that the Japanese Government had ordered in America £1,000,000 of electrical equipment, machines, tools and installation work for shipyards, arsenals, &c.

The "Duplex" Tumbler Switch.—The accompanying illustration shows a new type of switch just introduced to the market by Mr. A. P. Lundberg, in regard to whose inventive ingenuity it may be said that there is no falling off in fertility. By means of the patented movement in this type of "tumbler two-way switch with 'off' position," all three positions of the knob are well defined. It is specially adapted for use in positions where any vibration would be likely to jar contact arms of ordinary types of switches into their "off" positions, such as in tram and motor-cars, engine rooms, &c., as the improved construction locks the contact arms in their "on" positions, and prevents any possibility of annoyance caused by accidental rupture of the circuit. A source of annoyance in some switches is the possibility of both contact arms being in their "on" positions together; in the "Duplex" this defect is claimed to be satisfactorily overcome, as the improved action necessitates one contact being broken before the other can be made. The single spiral spring, as used, ensures similar tension on both contact arms, and also acts as a spring buffer for both contact arms arising into their "off" positions, thus preventing any jar to the fingers of the operator. As the "off" position is well defined, it is not too easily passed by, when releasing either of the contact arms from its "on" position. Four loop-in terminals, with $\frac{5}{32}$ in. (4 mm.) holes, are provided, and the connecting strap common to two of them being easily removable, allows the "Duplex" to be satisfactorily used as a "change-over" switch for controlling two quite distinct circuits, which may be of different voltage should occasion require.

The "Duplex" Tumbler Switch.

Electrical Items in the Indian Railways Administration Report for 1904.—Although the Indian Railway Returns do not chronicle the working of any branch or suburban lines by electric power, there are some items contained therein of an electrical nature. For instance, 485 coaches are lighted by electricity, of which nearly half—or 238—are in use on the Rajputana-Malwa metre gauge. The telegraph earnings of the whole of the railways treated as one system amounted to 800,000 rupees, a figure never before attained.

A South African Specification.—It was recently pointed out that South African contractors and dealers in building and engineering supplies were complaining of the faulty system of obtaining estimates on Government contracts in the British South African colonies. Too stringent wording of specifications and the limited time allowance for submitting tenders, were two of the complaints most often heard. A certain specification for tramway cars and machine tools, set out by the Johannesburg Corporation, has been severely criticised by the Johannesburg Chamber of Commerce and other bodies, the chief objection being that in the tender for machine tools the name of a certain manufacturer was specified. As a result of the matter having been energetically taken up, there is every prospect that the cause of complaint will be removed.—*Financial News.*

Bankruptcy Proceedings.—Wm. Jefferson—(Jefferson & Co., electrical engineer, Darlington). First meeting is to be held on September 22nd, at Middlesbrough; public examination October 18th, at Stockton-on-Tees.

Robert Pries (Durtnall & Pries), electrical sundriesman, 75, City Road, E.C. Receiving order made September 6th on a creditor's petition.

For Sale.—On September 27th Mr. E. A. Sherley-Price will offer for sale by auction the stock-in-trade, patterns and goodwill of the London Electromobile Syndicate, Ltd, See our advertisement pages for particulars.

Trade Announcements.—Messrs. Veritys, Ltd., announce that they are opening a ventilating department at each of their various branches. The new department will deal in the well-known "Aston" ventilating fans and blowers, and its services will always be available to the electrical trade where advice is required as to the best means of ventilating buildings and applying forced and induced draught. The department is under the superintendence of Mr. Oswald Stott, who has made a study of this work, and who has had great experience in the manufacture and application of blowers and fans.

Messrs. Shoolbred & Connell, electric light and power engineers, of 146, Fleet Street, E.C., have taken up the sole agency in this country for the sale of "Red Cross" lubricant for commutators, and they carry it in stock at the above address.

The head offices of the Electric Supply Co. of Victoria, Ltd., in the Colony are at Wendouree Parade, Ballarat, Victoria.

The business of Mr. G. Francis, electrical engineer, of 22, Crwys Road, Cathays, Cardiff, has been taken over by Messrs. A. J. Pierce & Co.

Mr. H. Moss has severed his connection with the Meteor Electrical Engineering Co., Bradford, and has been appointed manager of the electrical department of Messrs. David Wilson & Co., Bradford Road, Huddersfield, who have important work in hand.

The Scottish Steel Industry.—The *Times* says that this industry is at present very active. The Steel Co. of Scotland never had so many orders in their works as now. They have just received two important contracts from Continental Governments for steel of high resistance and steel of moderate thickness for deckplating of warships. They secured the contracts in competition over the Carnegie, Essen and other companies. The delivery will extend over two years.

Mechanical Stokers.—Messrs. Meldrum Bros., Ltd., of Timperley, have received an order from Messrs. Babcock and Wilcox, Ltd., for one of their mechanical stokers to consume a mixture of slack and locomotive smoke-box refuse under a large Babcock boiler, to be installed at Gateshead-on-Tyne for the North-Eastern Railway Co. The order followed a practical test of the stoker when burning the material at another installation.

Dissolutions and Liquidations.—Under the winding-up order made against the Garcin Renault Electric Cars and Accumulators, Ltd., Mr. H. M. Wincarls has now issued his report to the creditors and shareholders. The statement of affairs filed on August 18th shows unsecured debts £4,006; a partly secured debt £1,200 (securities valued at £500); preferential claims £70 16s.; assets £263 16s.; and a deficiency of £4,513. The unsecured creditors include loans £1,909 16s. 4d., law costs £66 1s. 6d., and ordinary trade creditors for goods supplied and work done £2,030 18s. 3d., including the costs of judgements, which several creditors have obtained against the company. Other property, returned as an asset valued at £200, represents an electric landaulette which has been sold by one of the company's employés in his own interest. There does not appear to be any prospect of a dividend for the creditors.

A. Herbert & Co., manufacturing electricians, 6A, Nightingale Works, 347, Hornsey Road, London, N. (Messrs. A. Herbert and Bennett), have dissolved partnership as from August 24th last. Mr. Bennett is now carrying on the business in his own name, and will attend to liabilities.

The Rhodes Electrical (Parent) Syndicate, Ltd., is winding up voluntarily, with Mr. Richard Salem, 70, Bishopsgate Street Within, E.C., as liquidator.

The Fireproof Electric Switchboard Co., Ltd.—Meeting to be held at The Lodge, Egerton Street, New Brighton, on October 18th, to hear an account of the winding up from the liquidator (Mr. Thomas Lomas).

Crompton Electric Supply Co., of Australia., Ltd.—Meeting to be held at Salisbury House, London Wall, on October 10th, to hear an account of the winding up from the liquidator (Mr. F. R. Reeves).

Messrs. W. J. Chesterton and A. J. Jones (Chesterton, Jones and Co., manufacturers and dealers in gas and electric light fittings, Walsall) have dissolved partnership, Mr. Jones will attend to debts and continue the business.

Messrs. G. S. Hooker and P. S. Harris (Hooker and Harris, electrical and mechanical engineers, Paragon Works, Retreat Place, Hackney, N.) have dissolved partnership. Mr. P. S. Harris will attend to debts and continue the business.

LIGHTING AND POWER NOTES.

Aldershot.—A L.G.B. inquiry into an application of the T.C. to borrow £2,000 for electricity works extensions was held recently.

Ashton-under-Lyne.—The Corporation has reduced the price of energy as under:—Lighting, first 250 units per quarter, 3½d. per unit, next 250, 3d.; all over 500, 2½d. Power, intermittent use, 1½d. per unit; continuous running motors, first 250 units per quarter, 1½d.; next 250, 1¼d.; next 500, 1d.; all over 1,000, 9d.

Ayr.—The report of the Corporation Electricity Department for the year, shows that during the 12 months about two miles of additional cable has been laid. The total number of consumers at the end of the year was 885, against 776 in the preceding year. The capital expenditure was £92,234, an increase of £4,709. The total revenue amounted to £12,251, an increase of £993 over 1904. The total working expenditure was £6,448; and interest and sinking fund charges amounted to £4,916, leaving a net surplus of £893, against £628 in 1904. A proposal that the charge to private consumers be reduced from 5d. to 4½d. was defeated.

Banbury.—The T.C. has decided to give notice to the Banbury Electric Supply Co. to put an end to the existing contract for lighting the public streets with electricity, and to substitute incandescent gas. The relative merits of the two lights was the subject of a long discussion, and the resolution to discontinue electric lighting, was carried almost unanimously.

Bangour.—An installation is being arranged for the new Bangour Lunatic Asylum, near Edinburgh. The total estimated cost is £15,000.

Bray.—On the 5th inst. the E.L. Committee reported that a flooding had caused the electricity works to be temporarily shut down and almost destroyed the weir at the head race. The No. 4 alternator had been damaged, but had been since repaired. The Committee recommended that the engineer and surveyor should meet Lord Meath or his agent with a view to having the weir repaired. The report was adopted.

Brighton.—The T.C. has sealed an agreement appointing Mr. Arthur Wright as consulting engineer to its electricity undertaking.

Burslem.—The erection of the electricity and refuse destructor works was recently completed, at a cost of between £30,000 and £40,000, and on the 5th inst. the dual works were formally opened by Mr. Robert Heath, High Sheriff of the county. The members of the T.C., of the Tunstall U.D.C., which is to be supplied with energy by Burslem, and of the Wolstanton U.D.C. (a portion of which area is also to be lighted from the works), and a number of invited guests, assembled at the Town Hall and marched in procession to the works.

The buildings consist of a destructor house, boiler house, engine room, offices, test room, and battery room. The refuse destructor, which was supplied by Messrs. Heenan & Froude, is of the 3-cell, front feed type, working in conjunction with a B. & W. boiler evaporating 6,000 lb. of water per hour, at a pressure of 200 lb. per sq. in. The electrical plant comprises, at present, one 100-kw. Howden-Dick, Kerr set generating at 440 volts; a G.E. Co. balancer-booster; an E.P.S. battery of 300 amp.-hours, and a switchboard by Messrs. Crompton & Co. The boiler house contains one hand fired B. & W. water tube boiler of 10,000 lb. capacity, at 160 lb. pressure per sq. in., fitted with a superheater. Two Weir pumps and a Wollaston water softener are also installed. Ten miles of cables have been laid, on the solid system, by Messrs. Callender, and there have been erected in the centre of the town twenty 8-amp. Crompton arc lamps. The plant has been running and consumers have been supplied since August 1st. The charges for energy to consumers are—a flat rate of 5d. per unit, or on the maximum demand system at 7d. per unit for one hour and 2d. after. The completion of the works has brought a demand for energy, and to supply this an additional 200-kw. set will shortly be added to the existing plant. Mr. A. Bremner is the borough electrical engineer.

Carrick-on-Suir.—Mr. H. T. Harrison, Dublin, has made a report on the proposed electric lighting scheme for the town, and estimates the cost at £13,000.

Dewsbury.—The T.C. has received from the L.G.B sanction to raise a loan of £9,762 for E.L. purposes.

Dundee.—Messrs. Gourlay Bros., shipbuilders, have offered to pay 1½d. per unit, for up to 25,000 units every three months. Energy required beyond that quantity is to be given at a reduced rate. The firm objects to a scale based on kilowatt demand.

Edinburgh.—The Parish Council and the E.L. Committee of the T.C. are at loggerheads over the question of assessment. The Parish Council wants to assess on a profit-earning basis. The revenue last year was £118,000. The Committee favours a steady rate.

Electricity v. Gas.—At a conference of the Gas Managers' Institute of Wales and Monmouthshire, held at Cardiff last week, it was stated that, despite all opposition, the industry was more prosperous in this country than ever. While in 1882 there were only 500 gas undertakings in Great Britain, there were now 719 such undertakings, supplying 151,677,693 thousands of cubic feet to 4,351,125 consumers. The capital expenditure on these undertakings was £117,972,458. The President in his address said that public lighting had had more attention from electricians than private lighting [!], but electric lighting had failed to give satisfaction in the public streets.

The Lighting Committee of the Wigan Corporation considers the cost of lighting Pemberton by electricity excessive, and recommends that gas be used in future, the change to be made by easy stages.

The Building Committee of the Stourbridge Guardians is divided in opinion as to whether it shall adopt electricity for the lighting of the new workhouse, and consideration of the matter has been postponed.

Mr. T. Rooke, city electrical engineer, Sydney, N.S.W., recently reported to the E.L. Committee on the question of street lighting, and dealt with the rival merits of electricity and gas as illuminants. He pointed out that the annual cost of the 766 gas lamps displaced by the electric lamps had been £5,085, and the cost of the 343 electric lamps erected was £9,947, but the electric lights were in reality cheaper on account of their superior illuminating power. He also advocated a progressive policy of electric lighting, stating that thereby the cost would be sensibly diminished.

Faversham.—The T.C. has reduced the cost of street arc lamps from £22 to £20 per annum, and that of other electric lamps from £4 10s. to £4.

Gillingham (Kent).—The T.C. has adopted a scheme of assisted wiring for private houses, shops, &c., payment being extended up to five years. The minimum cost of a 6-light installation will be £3, and after October 1st energy will be supplied at 4½d. per unit, or on a sliding scale at 7d. and 1¾d.

Govan.—The T.C. has reduced the alternative flat rate to consumers from 4d. per unit to 3½d.

Grimsby.—The T.C. has decided to extend the electricity station and plant at a cost of £9,500, and to apply for a loan of £18,000 for this and other electricity purposes.

India.—The Secretary of State is arranging for the machinery required for the new erecting shops of the North-Western Railway at Lahore, to be worked by electricity.

Irvine.—At a recent meeting, the E.L. Committee submitted a report on the proposed electric lighting scheme for the burgh, in which it recommended that the offer of Messrs. Marcy and Marr, London, to install the necessary plant, including a suction gas producer, at a cost of £6,646, be accepted. It was agreed to remit the report to the whole of the Burgh Commissioners in committee for discussion.

Italy.—The Milan provincial authorities have granted a concession to the Società Elettrica Industriale Franco-Italiana, of Milan, to put down a hydro-electric plant on the River Lambro at Cerro al Lambro, for generating electrical energy for lighting and power purposes.

Jedburgh.—The formal opening ceremony in connection with the installation of the electric light has been fixed for the 29th inst.

Ledbury.—Messrs. Foote & Milne have informed the U.D.C. that they intend to start a private local E.L. company, and the Council has decided to assent to the firm's application for a prov. order. Under an agreement, the Council will have the option of purchasing the undertaking at any time after seven years by giving a year's notice, the maximum charge for energy is to be 7d. per unit, and the actual charges are not to exceed the following, except with the Council's consent:—Ordinary consumers, 6d. for lighting, and 4d. for power; the Council, 4d. for lighting, and 3d. for power.

Llangollen.—The local E.L. Co. has offered to light the town lamps for £82 10d. per annum. Last year the gas bill was £360, and the Gas Co. has reduced its price to £140 4s.

Llandilo.—The U.D.C. has awarded the contract for working the E.L. station for a year to Mr. H. P. Davies at £302 for the first 22,000 units and 1½d. per unit afterwards, the contractor to do all reasonable repairs.

London.—City.—From the *Times* we learn that some experiments will be undertaken in the City, by the Corporation, on the 29th inst. to test the value of high-pressure gas for street lighting, as compared with electricity. The experiment is being watched with considerable interest by local bodies outside the City, many inquiries having been received at the Guildhall on the subject. The Corporation has arranged for the lighting of Queen Victoria Street and a portion of Queen Street, between Queen Victoria Street and Cheapside, by means of 45 high-pressure gas lamps in lieu of 27 existing electric arc lamps; the lighting of Fleet Street by means of 34 incandescent gas lamps, in lieu of the 12 electric arc lamps; and the lighting of Lower Thames Street, from Fish Street Hill to Billingsgate Market and Monument Street, by means of 33 high-pressure incandescent gas lamps. They will include a 1,000-c.p. lamp on each of the resting-places in front of Billingsgate Market in lieu of eight existing electric arc lamps.

Poplar.—The Electricity Committee of the B.C. has adopted a suggestion that a consumer who has paid the minimum charge in a quarter, may in the succeeding quarter have it deducted from his account, providing his account in the latter quarter is in excess of the amount of minimum charge paid. The Public Health Committee has decided to manufacture electrolysed salt water for disinfecting purposes, as offering a great saving in cost over ordinary disinfectants. This is an old idea, of doubtful value.

Hammersmith.—The price of energy for lighting purposes was, from 7th inst., reduced to a uniform rate of 3d. per unit.

Hackney.—With regard to the supply of water for condensing purposes, the E.L. Committee has decided to take water from the Lea Navigation Cut, in preference to the erection of additional cooling towers, which would be necessary if the water was taken from the River Lea. The Lea Conservancy has agreed to this course. The water is to be taken through two 18-in. pipes, a 27-in. pipe being utilised for the return; the rental will be £200 per annum, and £41 3s. 4d. per annum for the lease of the necessary land. The estimated cost of the necessary work is £4,000. The Committee has agreed to supply energy for power to Messrs. Ingram & Sons' London India-rubber Works, at £1 per kw. per quarter of maximum demand and ½d. per unit, for a period of seven years, with the benefit of any reduction in the present charges for power which may be made during the term of the agreement, to similar consumers.

Battersea.—The Lighting Committee has reported that on the 18th ult., at 8 p.m., No. 6 Parsons turbo-generator at the generating station broke down, owing to the displacement of part of the mechanism. No failure in the supply of electric light occurred.

Wandsworth.—Notice has been given by the County of London Electric Supply Co. that from October 1st the existing alternative flat rate of 6d. per unit for lighting purposes will be reduced to 5d. for shops and business premises, and 5½d. for private purposes. The scale of charges under the maximum demand system will remain as at present, and the charge for supplying basements where a light is used throughout the day, will be 3d. per unit.

Lye and Wollescote.—The U.D.C. has received from the Midland Electric Corporation, a letter offering a reduction in their flat rate of from 4½d. per unit to 3½d. in the case of prompt payment, and stating that in order that consumers might receive the discount, it would be necessary for the Council to give an assurance that it would not insist upon the discounts specified in its agreement with the company. The Council has, therefore, agreed to waive its claim to the discounts mentioned for five years, the question to be then further considered.

Macclesfield.—The T.C. has taken practical steps towards carrying out the E.L. order. A site has been selected for the station, and a loan of £15,000 to carry out the project, has been applied for.

Malvern.—The U.D.C. has applied to the L.G.B. for a loan of £2,500 for electricity purposes.

Mynyddislwyn.—A Pontypridd firm has informed the U.D.C. that application is to be made for a prov. order for E.L. in its area.

New York City.—The small generating station to light the Williamsburg Bridge, is to be in working order about October 1st. This is an experimental plant owned by the city, and it is intended to demonstrate the value of street refuse as fuel.

Paignton.—The B. of T. has informed the U.D.C. that it refuses to entertain the E.L. scheme of the Council in agreement with the Electric Construction Co.

South African Notes.— Ladybrand.—The T.C. recently discussed an offer from Mr. Knestner, of Johannesburg, to light the town on certain conditions. If the Council would give him a concession for 20 years he was prepared to lay down the plant, undertaking to have it completed in nine months. His charges would be 1s. 3d. per unit for house lighting and 1s. per unit for street lighting, the Council to have the option of taking the plant over in 10 years at original cost plus 20 per cent. The matter was deferred pending inquiries as to cost of electric lighting, &c., from the Town Councils of Potchefstroom and Winburg.

King William's Town.—In commenting on the fact that the working of the electric lighting undertaking had produced a profit for the past five months, the local journal expresses the hope that the T.C. will see its way to reduce the charge of 1s. 3d. per unit. The Government has offered 9d. per unit for lighting the railway station.

Stockport.—The T.C. has fixed the price of energy for motors at 1½d. per unit.

A sum of £882 to cover excess expenditure, is to be paid out of the reserve fund, instead of by a loan as proposed.

(*Continued on page 428.*)

THE WALTHAMSTOW ELECTRIC LIGHTING AND TRAMWAYS UNDERTAKINGS.

With the opening of the Walthamstow Urban District Council's light railway undertaking in the early part of June, another much needed, but long delayed, improvement was effected in the local travelling facilities of North-East London.

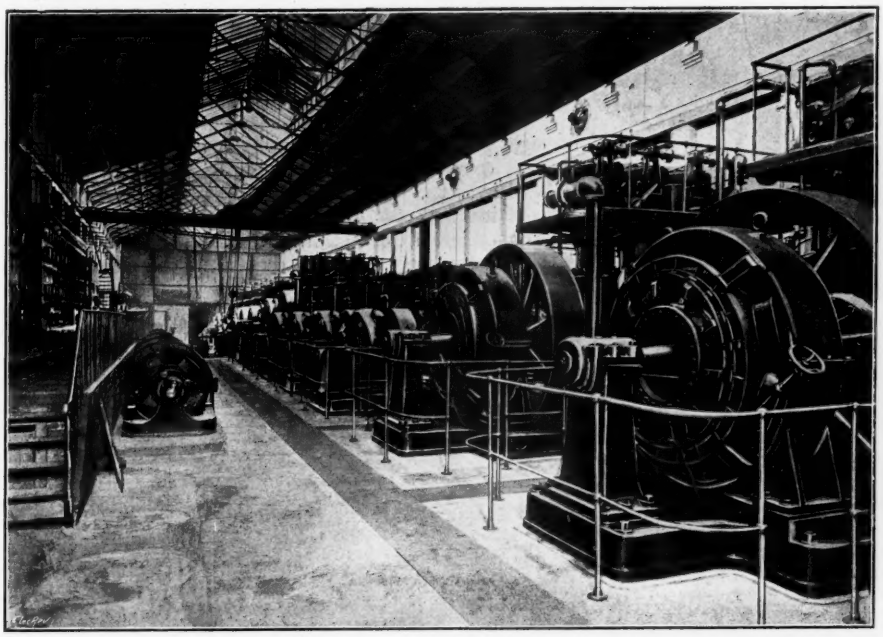


Fig. 1.—General View of Generating Plant: Original Lighting Plant in Foreground.

But further than that, the newly completed scheme has an added interest, in that energy for its operation is supplied from gas-driven plant, supplementary to the original installation, which has, since its inauguration in September, 1901, earned for itself such an excellent record for economical and efficient working among the London power stations.

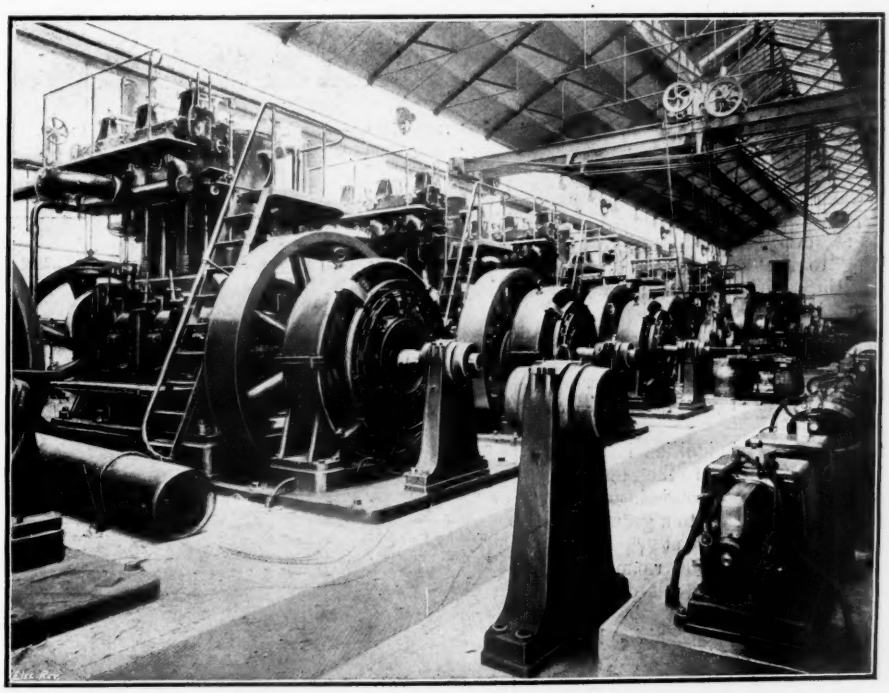


Fig. 2.—View of New Traction and Lighting Plant.

With its present equipment of plant, the Walthamstow electricity station is undoubtedly the largest gas-driven station in the country, and some preliminary reference to its main features, will, no doubt, be of interest to our readers.

A reference to our issue of October 18th, 1901, will give some idea of the plant installed at the opening, and a comparison of the views then given and the present ones forms an interesting commentary on the growth of the Walthamstow undertaking.

The engine room at present contains 13 generating sets, each consisting of a Westinghouse three-cylinder gas engine, direct coupled to a Helios d.c. generator.

Of this plant, the seven earlier sets (those installed before the recent building extension), comprising four 115-h.p. and three 250-h.p. units (illustrated in fig. 1) were utilised solely for lighting purposes; the six latest units (shown in fig. 2) are intended, three for lighting and three for operating the recently inaugurated light railways.

These later engines are, like the former, of the makers' well-known vertical single-acting three-cylinder type with cranks set at angles of 120°.

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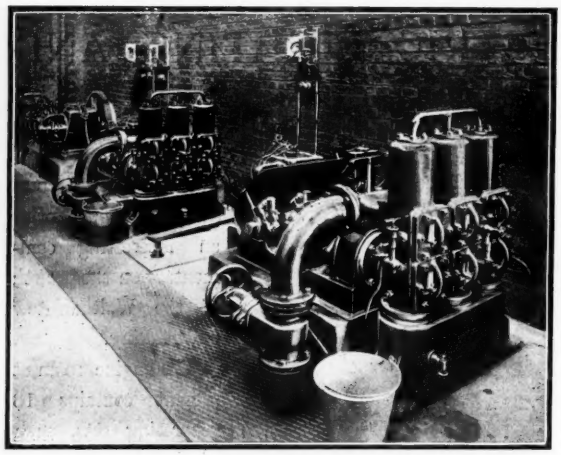

Fig. 3.—Motor-driven Air Compressor and Three-throw Circulating Pumps.

They are, however, of improved design, having only one internal camshaft for operating all the exhaust and inlet valves. The cylinders are in each case 20 in. diameter, and have a stroke of 22 in.; two 9 ft. diameter flywheels are fitted to each engine, and the latter have an overload capacity of 25 per cent. A mixing chamber is attached to each engine, with suitable hand valves for adjusting the proportions of gas and air, and a fly-ball governor controls the supply to the engine, the arrangement being that adopted on all Westinghouse gas engines, whereby the gas supply is varied at every second revolution according to the load, but is never cut off, thus giving the maximum number of impulses to the engine.

The exhaust valves are water-cooled, also exhaust manifold, the exhausts being connected to large silencers, consisting of iron tanks fitted with baffle plates.

Low tension electric ignition is provided, and a view of the miniature units, in this case consisting of a 200-volt motor coupled to a generator giving some 8 amperes at $\frac{3}{16}$ volt, and at a speed of 2,500 r.p.m. for energising the ignition circuit of each engine, is shown in fig. 4.

By means of a common ignition bus, running the length of the station, the various ignition motor-generators are made interchangeable, as a safeguard against breakdown in any particular set—a condition of affairs which is also guarded against by the provision of primary batteries.

The engines are started by means of compressed air at 200 lb. per sq. in., which is stored in vertical tanks placed against the engine room wall. The air compressors for feeding these tanks are motor-driven, one being illustrated in fig. 3.

The operation of starting-up the engines by means of compressed air is exceedingly simple and expeditious, some two minutes only being requisite for this purpose.

Referring to fig. 3, the two motor-driven three-throw plunger pumps seen in the foreground are, with other similar ones, used for circulating the cooling water in the cylinder jackets, this water being subsequently passed through cooling towers, of which the latest addition is specified to deal with 6,000 gallons per hour. The water required for make up and station purposes is derived from an artesian well, 480 ft. deep, in connection with which a motor-driven air compressor plant is provided for raising the water on the "air lift" principle, to a storage tank.

The gas for operating the station is generated in some eight producers of the Dowson type, arranged in two houses, with complete equipments of purifying plant and two gasholders; the more recently equipped producer house contains four 350-H.P. generators, each capable of consuming 500 lb. of anthracite coal per hour, and arranged so that the hoppers are at a convenient charging level.

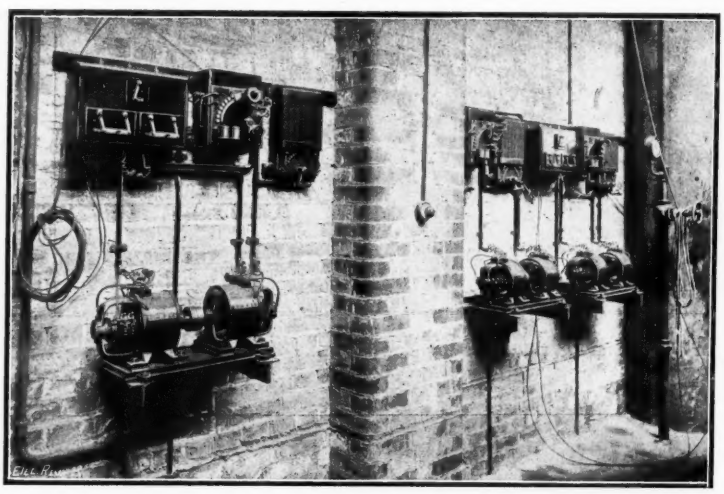

Fig. 4.—Miniature Ignition Motor-generator Sets for Gas Engines.

Each gas generator is provided with independent wrought-iron outlet and waste pipes, and with three coke scrubbers, a washer and a sawdust scrubber, the purifying plant being arranged outside the producer house as shown in fig. 9. In order that the gas supply to the engines shall be uniform, a 25-ft. gas holder is provided to each producer house; and for supplying steam to the producers, five vertical boilers are provided, three in the earlier and two in the later

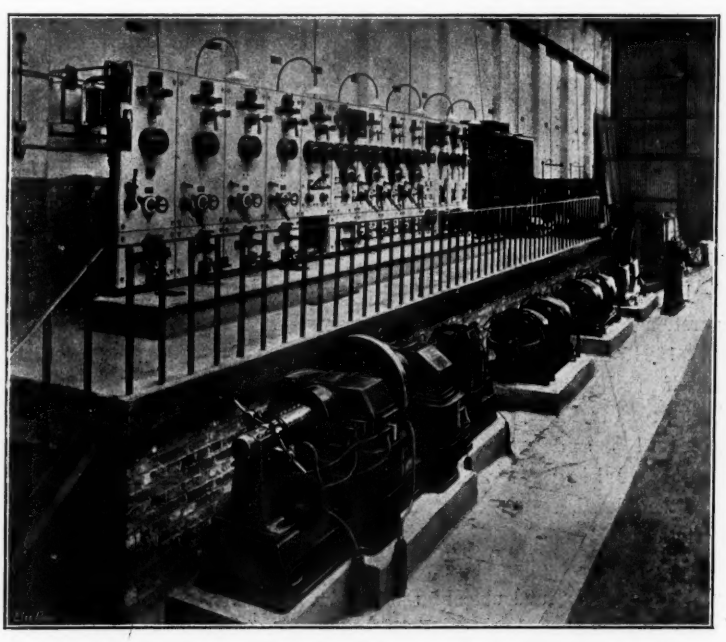

Fig. 5.—View of Traction Switchboard and Boosters.

building, illustrations of which appear in figs. 6 and 7 respectively.

The method of working these producers, in common with others of the power gas variety, has frequently been referred to in the ELECTRICAL REVIEW; their operation results in the production of a cheap gas of about one-fourth the thermal value of coal gas, and costing some 2d. per 1,000 cubic ft. The fuel consumption is probably less than 1 lb. per B.H.P.-hour, and the fuel used at Walthamstow is anthracite pea nuts, costing some 25s. per ton delivered over the railway siding which connects the works with the Great Eastern Railway Co.'s Chingford branch.

The electrical generators throughout are of the Helios type, the earlier ones being six-polar machines with a capacity of 150 amps. at 460—560 volts and at a speed of 260 r.p.m.; later additions, both for lighting and traction purposes, are 10-polar machines with a normal speed of 200 r.p.m.

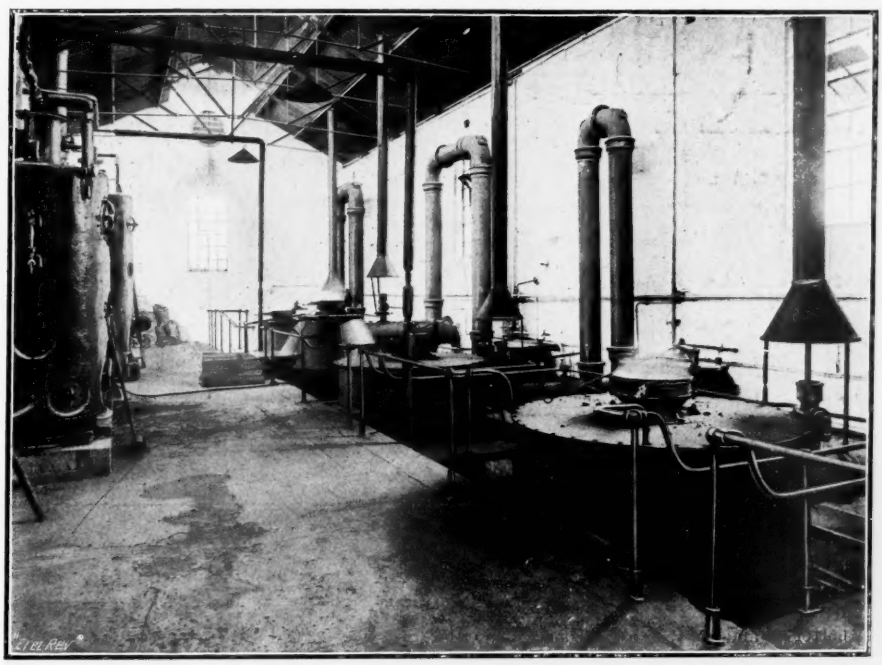

FIG. 6.—ORIGINAL GAS-PRODUCER HOUSE: FIRST INSTALLATION.

The three traction generators each have an output of 185 KW. at 460 to 560 volts, and, in common with the rest of the machines, are shunt wound and regulated entirely on their shunt resistances.

The armatures of these machines are of the slotted drum type with built-up cores mounted on cast-iron spiders, keyed to the shafts.

The magnet windings are in sections for the purpose of increased cooling. The machines are designed for a fixed brush-position throughout all normal load conditions.

In addition to the foregoing generators, there are provided in connection with the lighting plant, two balancers of 20 and 50 KW. capacity respectively, and two boosters for charging the lighting battery and regulating the feeder voltages, &c. Each of these sets consists of two four-pole machines, flexibly coupled together; and a further set, in the shape of a small milking booster, is provided for dealing with individual battery cells.

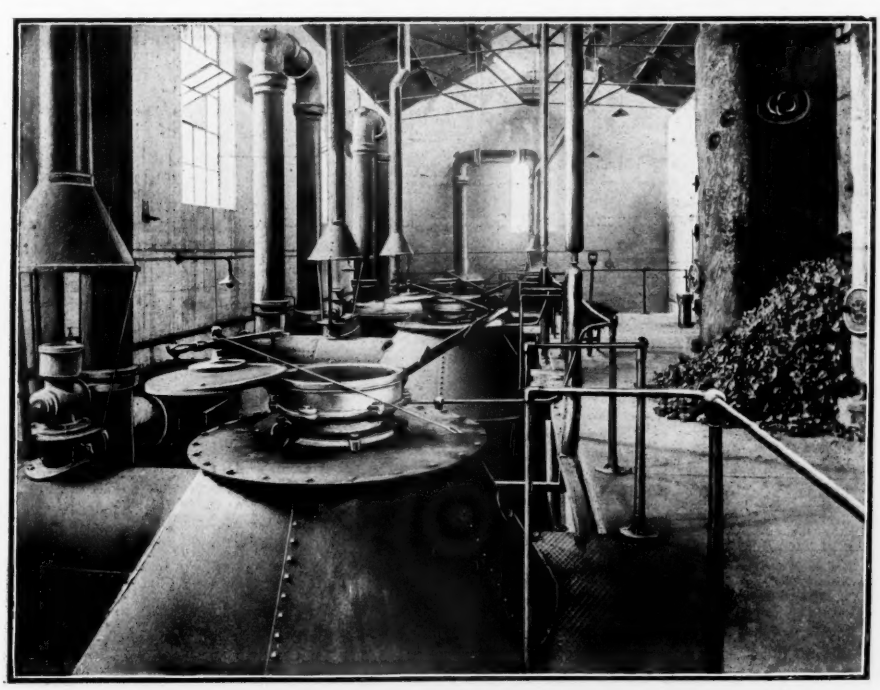

FIG. 7.—NEW GAS-PRODUCER HOUSE.

All the above plant is arranged in front of the main lighting switchboard, which, as first installed, was described in our earlier article, and has since been extended by the addition of machine and feeder panels, to keep pace with the growth of the station and supply network.

For traction purposes four booster sets have been installed in front of the traction switchboard, which occupies a position on the same side of the engine room as the lighting board, but opposite the generators which it controls.

Two of the booster sets are capable of giving any current up to 300 amperes at up to 40 volts, and the third will deliver up to 185 amperes at pressures up to 30 volts. Each of these sets consists of a motor direct coupled to a booster, and designed to carry the usual overload.

Fig. 8.—Car-Sheds and Repair Shops.

The fourth booster (built by the Electric Construction Co.) is of the Highfield type, for working in connection with a traction battery, and has a speed of 1,000 r.p.m., and a normal output of 200 amperes at 75 volts.

The traction switchboard, fig. 5, was built by Messrs. Johnson & Phillips, and consists of 12 white marble panels including the following:—Four generator, three feeder, three ordinary and one Highfield booster panels: also a Board of Trade panel. The instruments are similar to those used in connection with the lighting board, and each panel is self-contained as far as possible.

The battery room and workshop, with a suite of offices over, are situated at one side of the engine room immediately behind the switchboards.

The lighting and traction batteries are situated adjacent to their respective switchgear; the former consists of two batteries of the Tudor type, arranged on either side of the three-wire lighting network; each contains 142 cells, mounted in two tiers, and has a maximum rate of discharge of 500 amperes at 250 volts.

The traction battery is composed of 244 cells, arranged in one tier and insulated from the floor by oil insulators. This battery has a capacity of 220 amperes for three hours, or 500 amperes for one hour.

It may be here mentioned that the principal contractors in connection with the recent traction generating plant, as also for the original installation, were Messrs. Frank Suter & Co., who obtained the contract for the engines, generators, switchgear, gas plant, &c.

The question of providing tramways in the Walthamstow area was under consideration by the Council as far back as 1898; the present scheme of light railways, however, received Parliamentary sanction in February, 1903, and the official opening was held in June of this year.

It is satisfactory to record that mutual running powers agreements have been arranged between the Walthamstow and Leyton Councils over the whole of the lines in both districts: also that a further arrangement has been come to with the North Metropolitan Tramway Co. for mutual running powers, which will give direct communication almost to Regent's Park.

Altogether some nine miles of single track have been constructed to a gauge of 4 ft. 8½ in.; turnouts being provided, five to the mile, in the thickly populated routes, and four to the mile in the outlying portions.

The track work is of normal construction: the rails of girder type weigh 100 lb. per yard, and are anchored by means of the Cooper rail joint, every 45 ft. The points and

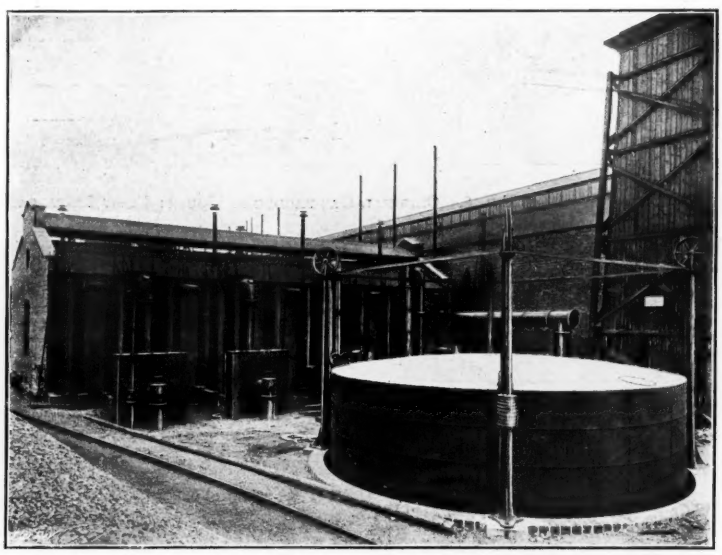

Fig. 9.—Exterior of New Producer House, Showing Purifying Plant, &c.

Fig. 10.—View on Chingford Route, Showing Arc Lamp Suspension.

crossings are of Askham Bros.' make. Granite paving has been used, grouted in with bitumen grout, over the greater portion of the routes. The construction of the light railways necessitated the building of two new bridges and the widening of four others.

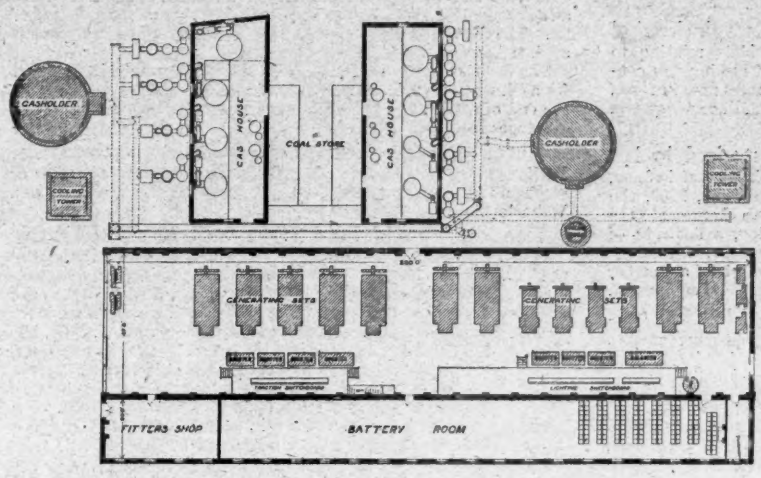

Fig. 11.—Block Plan of Walthamstow Generating Station.

The overhead work is mostly of side bracket type, as shown in fig. 10, where also the system of arc lamp suspension from alternate bracket arms can be seen.

At the various termini automatic trolley reversers are fitted, the trolley standards on the cars being, in consequence of this, constructed so that the heads can revolve in either direction.

A device for cutting off the current from broken trolley wires has also been provisionally adopted on certain routes.

For dealing with the traffic some 32 double-deck single-truck cars, each with a carrying capacity of 50 passengers, have been provided. These were built by the Brush Electrical Engineering Co., and have Westinghouse electrical equipments, including magnetic brakes.

A car shed, repair shops and spacious tramway offices have been erected on the Chingford route, a short distance from the central junction of the East-West and North-South routes.

The repair shops, which embrace a smithy, store room, armature winding shop, paint store and paint shop, and a carpenter's shop, are provided with modern electrically-driven machine tools.

A general view of the car-shed and a standard car is given in fig. 8.

Messrs. W. T. Henley and Co. obtained the contract for the permanent way, overhead equipment and cables, but sub-let to Messrs. Dick, Kerr & Co., the first two sections of the work: the British Westinghouse Co. were the contractors for the cars, with the Brush Electrical Engineering Co. as sub-contractors.

In conclusion, we may say that Messrs. J. and J. S. Enright have acted as consulting engineers for all the Walthamstow electrical undertakings, and that to Mr. F. A. Wilkinson, until recently the Council's electrical engineer, and his successor, Mr. J. H. Fooks Bale, is due the credit for the successful operation of the various undertakings.

To the latter gentleman we tender our thanks for the assistance and facilities which he has given us in the preparation of this article.

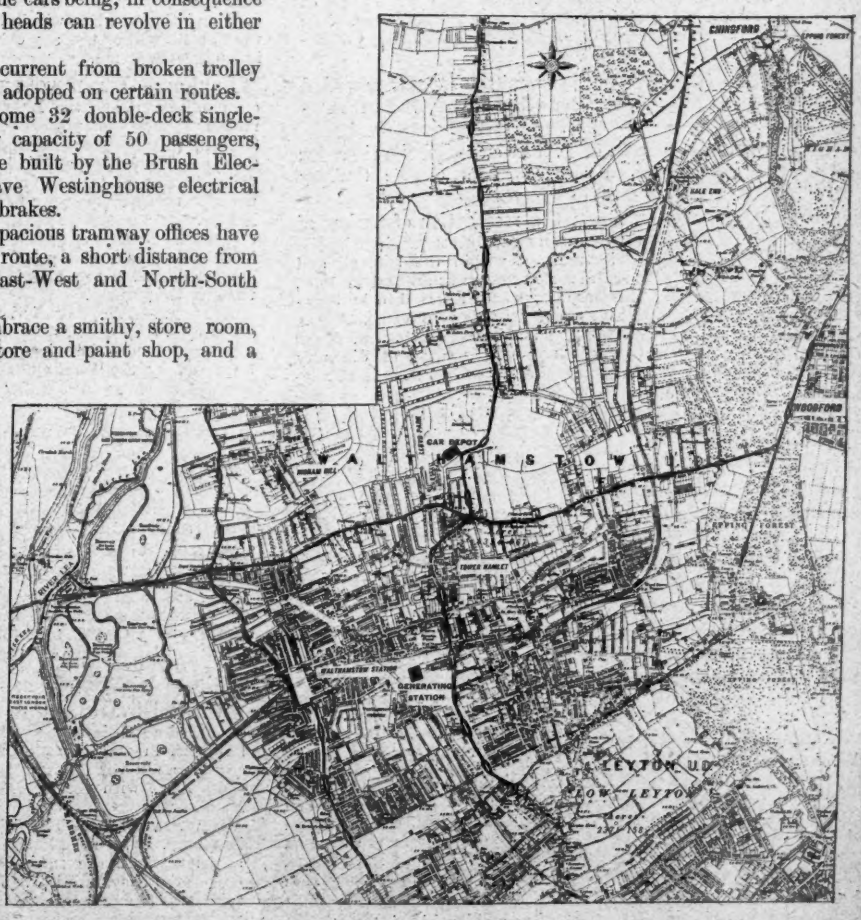

Fig. 12.—Plan of the Walthamstow Area, Showing the Light Railway Scheme.

The Diffusion of Nascent Hydrogen through Iron.—The current number of the *Annalen der Physik* (No. 9, 1905) contains an important paper by A. Winkelmann descriptive of experiments upon the diffusion of nascent hydrogen through iron, an extension of his recent researches on diffusion through glowing palladium and through glowing platinum. In the present experiments the iron tube through which the action takes place is 20·1 cm. long, and 1 cm. in diameter, the walls being 0·0451 cm. in thickness. It is closed at the lower end, and dips to a depth of 7 cm. into an electrolyte consisting of a 1 per cent. solution of a sodium salt. The iron tube is maintained as the cathode, the anode being a platinum wire; the current is kept constant at 0·001 ampere. The upper end of the iron tube is fitted gas-tight into a glass graduated tube which is at once bent over, the lower end being kept beneath a mercury surface. Near the bend is a tubulure provided with a stop-cock, which can be attached to an air pump. This arrangement enables measurements to be made of the volume and pressure of the hydrogen that diffuses through the iron tube from its outer surface to the interior during electrolysis. The quantity of hydrogen so diffused is found to be independent of the pressure within the tube—at any rate, from 0 to 89 cm. of mercury pressure. Similarly it is sensibly independent of changes of pressure upon the surface of the electrolyte—*i.e.*, pressures outside the iron tube—of, say, half an atmosphere. The pressure of diffusion is therefore something quite distinct from the surface pressures; the lower limit for this pressure of diffusion is estimated to be about 58 atmospheres. With constant current, diffusion increases with the temperature of the electrolyte; the equation takes the form

$$D_t = D_0 (1 + \beta t)$$

where $D_0 = 0{\cdot}656$ and $\beta = 0{\cdot}0455$. The author deduces that it is proportional to at least the 4·97th power of the absolute temperature. At constant temperature, with increasing current, the diffusion increases, but more slowly than the current. At constant temperature, with constant electrolyte and electrode conditions, the diffusion is found to be very nearly proportional to the potential difference between the electrodes.

LIGHTING AND POWER NOTES.

(*Concluded from page* 422.)

Stretford.—The annual report of the Electricity Committee has been submitted to the T.C., and states that the gross profit amounts to £3,363 and the net profit to £528.

Swansea.—Mr. C. A. L. Prusmann, the borough electrical engineer, has recently issued a couple of pamphlets relating to electricity charges in the area; one of these seeks to impress consumers with the saving effected by the reduced rates now in force, and the other is an explanation of the maximum demand system of charging.

Sydney (N.S.W.).—A picture-postcard received by last mail from the Empire Electric Light Co., Ltd., shows that in June, 1898, the company had 348 lamps connected; in June, 1902, the number was 13,440; and to-day, 36,560. The rates charged are the same as those of the City Council, viz., for lighting, a flat rate of 4½d., or 5d. and 2d. on the maximum-demand system; for power and heating the charge is 2d. per unit. The card gives a number of views in miniature of the generating station and its equipment.

Waterford.—The National Provincial Electrical Corporation has intimated to the T.C. that it intends applying for E.L. powers for the district.

West Hartlepool.—A statement was submitted by the borough accountant recently, showing a loss on the year's working of the electricity undertaking of £471, against a loss in the previous year of £560. An additional charge of £361 was placed to interest, and £450 was set aside for reserve and depreciation.

TRAMWAY AND RAILWAY NOTES.

Belfast.—It is expected that electric traction will be in force all over the tramway system about the second week of November. This is a fortnight over the stipulated time. The work is progressing satisfactorily, all the new lines being practically completed.

Bradford.—The Tramways Committee has recommended the T.C. to apply to the B. of T. for a loan of £30,079 for the construction of electric tramways at Wyke.

Cleckheaton.—The B. of T. has extended the time for constructing the Cleckheaton and Hightown electric tramway extension for a year from August 30th.

Dudley.—It will be within the recollection of readers of the Electrical Review that an agreement for the purchase by the Town Council of the electric tramways within the borough and the letting of them at a rental for 21 years was drafted in 1897, and it fell due in 1904. This has always been referred to by tramway companies and others as the "Dudley Agreement." A few months ago it was reported that an alternative agreement was under consideration, but it would now appear that some difficulty has arisen, for in a Town Council report issued last week the Tramway and Electric Lighting Committee alludes to a report of a sub-committee as to the purchase of the tramways, and the Committee recommends the Council to carry the original agreement to arbitration.

Dundee.—An excellent illustration of what the difference in gradients means, is shown by comparison between the tramways in Dundee and Aberdeen. Although the Dundee cars are worked as economically as possible, and the fuel cost is brought down to 1·88d. per unit, yet if Dundee had been able to run as cheaply as Aberdeen, there would have been a saving last year of £3,200. One of the principal streets in Dundee has a gradient of 1 in 11, up which cars weighing 13 tons have to be propelled. Surely there is a good opening for regeneration there.

Durham.—The B.E.T. Co. is applying to the B. of T. for an extension of time to October 4th, 1906, for completing the work included in the Durham and District Light Railways Order, 1901.

East Ham.—At the meeting of the U.D.C. on Tuesday it was reported that a dead-lock had been come to with respect to the proposed working of the Barking tramways. The Barking Council desires to have a clause to terminate the agreement when the lines are extended from Ripple Road to Fanshawe Avenue. East Ham requires exclusive running powers from the Eastern boundary of the borough to the Western boundary of East Street, Barking, for seven years certain, and for joint running along East Street to Ripple Road.

Liverpool.—A test case of considerable interest was heard before the deputy-stipendiary magistrate of Liverpool (Mr. J. Kinghorn) on September 6th, when Colonel John Pilkington was summoned for non-payment of 1d. excess fare on a tramcar. Mr. Clayton, for the Corporation Tramways Committee, said defendant paid 1½d. He continued in the car beyond this fare, and the conductor requested him to pay an excess fare of 1d. Defendant proffered ½d., which the conductor could not accept, as he had no ½d. tickets. There were no ½d. fares as such on the Liverpool cars. Defendant said he declined to pay more than the ½d., as a matter of principle. The total fare to any part of Wavertree was 2d., and he contended that having paid the 1½d., and subsequently the ½d., he had paid the full fare for a distance even beyond where he got off the car. The magistrate dismissed the summons, taking the view that the regulation affecting the matter was designed to meet cases where a person intentionally and wrongfully tried to get out of his liability, whereas in this case the defendant had not tried to evade liability, but had paid the 1½d. and an additional ½d., which was equal to the amount of the full fare of 2d. The mere fact that the tramways undertaking did not possess a ½d. ticket was not defendant's fault.

The decision raises the question whether a person who has paid for a ½d. stage is entitled, on paying an additional ½d., to travel to the end of a 1d. stage, which is often nearly twice as long as two ½d. stages together.

Hazel Grove.—The U.D.C. has been informed that Parliamentary powers are to be applied for, for the construction of electric tramways connecting Stockport with Macclesfield and Wilmslow.

Ipswich.—On Wednesday last week Mr. M. K. North, L.G.B. Inspector, held an inquiry into an application on the part of the T.C. for authority to borrow £19,500 for street improvements in connection with the reconstruction of the tramways, as well as for additional rolling stock. Mr. Bantoft, town clerk, stated that the expenditure upon the undertaking to the close of March, 1905, had been £107,785. Additional rolling stock had been found necessary, and the cars had been purchased and were now in use. It was admitted that the work had been done before the loan was applied for. The work was begun in 1902 and finished in 1904. The inspector said the L.G.B. would probably deduct two years from the life of the work. The inquiry was declared closed.

Johnstone.—At a meeting of the T.C. the clerk was instructed to write to the Tramway Co. insisting that the tramway system be carried to the boundary of the burgh, a matter that was agreed upon when the tramways were introduced into the town.

Llandudno-Colwyn Bay.—The Llandudno U.D.C. has decided to support the application of the Tramways Co. for a further extension of six months in which to construct the electric tramways to Colwyn Bay, provided that £1,000 be lodged with the Council's bankers as security that the company will spend £9,000 on completing the line within the town in six months. Otherwise the Council will oppose any extension of time, and will promote an independent scheme.

London.—Wandsworth.—The B.C. has received a communication from the L.C.C. stating that the Highways Committee proposes that powers be sought in the coming Parliamentary Session, to construct new tramways from Clapham *via* Clapham Common, North Side, and Cedars Road, to Lavender Hill, with the view of a through tramway route being established in conjunction with the existing tramways in Queen's Road, Battersea, to Chelsea Bridge. At a later date consideration will be given to the question of providing means of communication from Clapham to East Hill, Wandsworth, and subsequently, it is hoped, to Roehampton along one or other of the routes which have been suggested from time to time for the purpose.

Holborn.—The plans of the L.C.C. for the reconstruction of the tramway in Theobald's Road, and the construction of the connecting section to the subway approach under Kingsway, have been approved by the Works Committee. The reconstruction of both lines of tramway in Theobald's Road is to be proceeded with simultaneously.

Newcastle-on-Tyne.—At the meeting of the T.C. on the 6th inst., it was decided to make an application to the B. of T. for a prov. order to authorise the construction of a tramway in the extension of Market Street from Pilgrim Street to New Bridge Street. The main purpose of the change is to relieve the extremely heavy traffic at the corner of Northumberland, Blackett, New Bridge, and Pilgrim Streets.

Oxford.—The T.C. has decided to electrify the tramways which are to be taken over from the local tramways company, and the overhead system is recommended. The estimated cost is £93,295, with £36,852 for extensions of the present system.

Sneinton.—Nottingham T.C. proposes to construct six new lines of electric tramways, giving communication with Sneinton.

United States.—Chicago.—Mr. William S. Reed has organised a syndicate to purchase the Chicago Electric Co., which has been in the hands of a receiver. The syndicate intends to acquire a number of electric street car lines and to build sundry short lines, with the ultimate view of connecting Chicago with New York.

Niagara Falls.—The Westinghouse Manufacturing Co., of Pittsburg, Pa., will build a large factory on the Niagara frontier, at a point where the transmission line of the Ontario Power Co. crosses the Niagara River. President Roosevelt is being asked to take steps to create an international commission for the purpose of preserving the amenities of the Falls.

New York Central R.R.—It is stated that this company is preparing to equip with electricity not only its suburban lines but the whole network of 8,000 miles of railway, obtaining the power from Niagara Falls. On August 16th, says the *Manitoba Free Press*, the Ontario Power Co. sold 60,000 H.P. to the Central.

Worcester.—The T.C., on September 6th, decided to assent to the transfer of the tramway undertaking in the city from the Worcester Tramway Co. to the Worcester Electric Traction Co. for £6,500.

TELEGRAPH AND TELEPHONE NOTES.

Channel Islands.—The Post Office notifies that telegraphic communication with the Channel Islands by the English route is interrupted. It is hoped that a wireless service *vid* Alderney will soon be available.

Durban.—It is reported that the Government has declined to sanction the application of the Marconi Wireless Telegraph Co. to establish a station on the Bluff. The company asked for a free lease of 100 yards for 25 years, offering in return to receive and dispatch official messages at half rates. The Union Castle Co. had promised to equip their vessels with the necessary apparatus. It is stated that similar applications were being made as affecting Delagoa Bay and the Cape Colony.

Glasgow Telephone Accounts.—The annual accounts of the Glasgow Corporation telephone department were severely criticised at a recent meeting of the Town Council. In moving the adoption of the accounts, the convener (Mr. James Alexander) pointed out that the annual revenue had steadily advanced. In the first year of the enterprise it was £14,096, in the second £35,014, in the third £49,639, and last year £55,426. During the same period the expenditure had gone up very considerably. In the first year it was £13,698, in the second £33,320, in the third £46,000 and last year it was £53,922. Out of this expenditure, however, they had set aside for sinking fund during the four years £36,163 6s. 8d. Last year the sum was £10,053 6s. 8d., and for the general depreciation fund for the same period £7,247 13s. 5d. The two sums amounted to £33,411, which, no doubt, would be a good stand-by in case anything should occur to depreciate the undertaking. They had paid in royalties to the Post Office £15,330. The Corporation had received in taxes something over £5,000, while the department had provided employment for 588 persons, the female staff alone numbering 293. The balance was not so large as in the previous year. The department had been subjected to very excessive competition and under-cutting of rates during the year. The competition had been carried on by the Telephone Co. regardless of cost, which it recouped by charging higher rates in other places, thus making subscribers in other towns pay for the benefits which the Glasgow subscribers were receiving in cheap telephones. The telephone department only operated in the city and neighbourhood, and had no reserve places to fall back upon. It had to stand on its own legs. It had during the year not only paid its way, but had been able to put 3·79 per cent. as a provision for the future. According to the National Telephone Co.'s thirty-third report they only made provision for the future to the extent of 1·52 per cent. He expected they would be told, as they had been told in previous years, that revenue charges had been placed to capital. To that he gave an unqualified denial. The accounts had been subjected to a rigid examination by the auditors, a firm of high standing, and that in itself was surely sufficient guarantee that everything had been done in perfect order.

In moving that the accounts be remitted for further consideration, Mr. W. F. Russell described the accounts as the most unsatisfactory that had been put before them in the short history of this department. To earn an increased revenue of £5,717 there had been an increased expenditure of £7,954—in other words, as compared with last year, the accounts were £2,147 worse, and the balance left to be carried forward was £1,504 5s. 11½d., this balance being all that was available for depreciation. They had been told from time to time that the benefit from the unproductive plant would very soon be shown. These accounts showed that there was a capital expenditure of £29,429, and the bulk of that expenditure had been incurred in connecting 957 new stations, equal to £30 16s. 3d. per instrument; so now they were brought face to face with the fact that their unproductive plant was of little use for further extensions. The expenditure per station amounted to £4 7s. 2⅝d., and he presumed it would continue growing. Now against this expenditure they had a total revenue per station of £4 9s. 3d., leaving a margin of 2s. 5½d. to meet depreciation on a capital expenditure of £28 6s. 8½d. per instrument. Taking it another way, the percentage of total expenditure to total revenue was 97·28, leaving only a margin of 2¾ per cent. Then the sinking fund, together with the so-called "depreciation fund," only amounted last year to 3·79 per cent., or nearly 1 per cent. of a reduction from previous years. He was afraid that next year would show that the total expenditure had exceeded the total revenue. Now taking the accounts as correct, he asked how they proposed to face next year, as an increased sinking fund of £1,100 would practically wipe out any possible surplus. Eighteen months ago, when he protested against further borrowing powers being given until increased charges had been agreed to, Mr. Gray stated that whenever he could show from the accounts that an increase was warranted, the Corporation would agree to it. He would therefore ask him to support the amendment. Quoting from the accounts, Mr. Russell contended that the loss on the working of the department as at this date was £40,600, and proceeded to point out that there was very little time left to provide against a very serious loss in this undertaking, only eight years remaining in which to write down their capital to the sum that was likely to be paid by the Government. It would take £17,500 to provide for a 5 per cent. depreciation next year, and, supposing they raised their flat rate to seven guineas, it would produce an increased revenue only equal to the depreciation they were bound to wipe off.

Mr. Mathieson, who seconded, held that the accounts showed the undertaking to be financially unsound. The increased working expenses had marched almost pound for pound with increased revenue. The earning of that increased revenue had actually cost £7,922 more in total expenditure, being the items of increased working expenses, plus increase to sinking fund and interest on loan. In the statistics the amounts which were designated as net revenue for last year now appeared as total revenue. Last year the percentages given were thus made to appear as applicable to net revenue, or revenue after deduction of working expenses. That had been corrected, and the same percentages which had formerly appeared to be applicable to net revenue, now appeared as applicable to total revenue before deduction of working expenses.

Mr. Hugh Alexander supported the accounts. If it was wise for the Government to have a telephone business, and to content itself with 1-34 as a sinking fund, surely the Glasgow Corporation were doing better by putting aside 1-30. The capital was £350,000, and they had something like £33,000 between depreciation and sinking fund. The sinking fund would amount to £11,000. Suppose they were never able to pay more than the sinking fund, they had eight years in which to gather other £88,000. Adding that to the sum they had they would have something like £121,000 to set against £333,000. He did not believe that the Government, who professed that they were sound at 33 years, could have the courage to offer less than two-thirds of the value.

Mr. D. M. Stevenson, in supporting the motion, said that what they had to do was to get a sufficient revenue to pay working expenses, renewals, and interest on capital. This, he maintained, was being done by the Corporation, and it was not conceivable that in 1913 the Government, which acquired the National Telephone system at a price which had sent up their stock from £66 to £113, would deal less generously with the Corporation.

The accounts were ultimately adopted.

Inland Telegrams.—The *Standard* of 12th inst. contains some interesting correspondence between the General Post Office and Mr. E. B. Broomhall, concerning the use of 10-letter pronounceable code words in inland telegrams. The Post Office states that "it has been the practice of the Department to accept them by way of toleration, and instructions have been given that for the present this practice is to be maintained." This is satisfactory, and it is to be hoped that this concession (although we do not see on what ground exception was taken thereto) will be made permanent. Experience has shown that the system of counting on the Inland system also clashes with that in vogue on the lines of cable companies, for apparently it is the custom of the General Post Office officials not to transmit inland telegrams as written, and when words are telegraphed which the cable companies charge as one, and are so written, the telegraph offices not only charge according to their ruling—to which there is not much objection at ½d. per word—but also insist on separating the word. This operates to the disadvantage of senders of Press telegrams, as very often such messages are sent direct to the cable companies from some inland telegraph office, and the companies transmit and charge for the message as received, causing unnecessary and vexatious loss to the sender. It seems obvious that Post Office arrangements for inland messages should be brought into line with those for foreign countries if proper freedom and full benefit is to be given.

Newfoundland.—The new cable laid between Canso and Port-au-Basque, Newfoundland, was opened for service on the 11th inst. The cable is owned by the Newfoundland Government, and will be worked in conjunction with its landline system.

New Zealand.—According to Australasian advices received in London by Monday's mail, Sir Joseph Ward, the Postmaster-General of New Zealand, has expressed the opinion that with the co-operation of the Australian Federal Government, wireless telegraphy will be established across the Tasman Sea within one year. One station will be at the south end of South Island. There will probably be a transmitting station at the Lord Howe Islands. The equipment placed at Auckland and at the Macquarrie Islands will cost £28,000.

The Telegraph Cable Export Trade.—The fluctuating character of the export trade of this country in telegraph cables and apparatus connected therewith, which has frequently been referred to in these columns, is strikingly shown by the returns for August now available. For a long time this branch of trade has been very quiet. Last month proved, however, unusually active, the shipments amounting to no less than £440,329, as against only £44,894 in the previous month and £50,377 in August a year ago. Last month's exports are, in fact, the largest since July, 1902, and bring up the total for the first eight months of the year to £1,109,342, an increase of £515,122 over the corresponding period of 1904.

Telegraph Convention.—The German and Belgian Governments, according to the power reserved in Article 17 of the International Telegraphic Convention of 1875, have renewed the agreement entered into between them for a new period corresponding to the duration of the London Revision, 1903, of the Service Regulations. Similarly, France and Belgium have renewed their contract, which is to remain in force till either party gives six months' notice of its termination.

Telegraph Reunion at New York.—The twenty-fifth annual reunion of the Old Time Telegraphers and Historical Association was held at New York City on August 31st-September 2nd, when nearly a thousand telegraphers from all parts of the U.S.A. were present. Mr. Thomas Edison was among those who attended the annual dinner, and he met an old boyhood friend, Mr. Cam Culbert, whom he had not seen for 40 years. Others present at the gathering were Mr. T. W. Goulding, London superintendent

of the Western Union office, and Messrs. J. S. Greene and W. A. Sheldon, who were military telegraphers during the American civil war.

Submarine Signalling.—The Mersey Docks and Harbour Board has decided to adopt submarine signalling, first making a trial of the system in question on the North-West Lightship, near the bar of the river.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Closed { Vladivostock-Nagasaki	Feb. 9, 1904	
Closed { Port Arthur-Chifu	Mar. 9, 1904	
Tarifa-Tangier	Jan. 18, 1904	
Jamaica-Colon	Jan. 5, 1905	
Iquique-Antofagasta	July 21, 1905	Sept. 8, 1905.
Cadiz-Tenerif	July 20, 1905	
England-Guernsey	Sept. 6, 1905	
Landlines.		
Puerto-Barrios	July 28, 1902	
Kertch-Soutehoum	Sept. 27, 1904	
Alaska landlines	Aug. 27, 1905	
Communication with Brazil *via* Galveston	July 18, 1905	

Wireless Telegraphy.—*L'Electricien* states that the United States Government has decided to establish a wireless station at New Orleans on the "Telefunken" system. Should it prove successful, communication will be established with Colon, a distance of 2,900 kilometres.

The French Government is about to establish wireless telegraphy at Cherbourg, Toulon and Bizerta.

It is also stated that a wireless system is to be established between Dervah, North Africa, and Patara, Asia Minor, a distance of 800 kilometres.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bishop Stortford.—September 26th. The U.D.C. is inviting tenders for lighting such of the public streets as are at present lighted, for two or three years from September 30th, 1905. Thomas Swatheridge, Clerk of the Council.

Burton-upon-Trent.—September 25th. Feeder cables, conduits, &c., for the Corporation tramways. See "Official Notices" September 8th.

Chiswick.—September 29th. Wiring refuse destructor and other buildings for the U.D.C. See "Official Notices" to-day.

Dublin.—September 18th. Sub-station switchboards, transformers and mains for the Corporation. See "Official Notices" September 8th.

France.—September 26th. The French Post and Telegraph Authorities in Paris are inviting tenders until the 26th inst. for the supply of 216 kilometres of submarine cable core, 50 tons of iron wire, 2½ mm. diameter; 10 tons ditto, 5 mm. diameter; 350 tons ditto, 7 mm. diameter, and 100 tons ditto, 8 mm diameter. Particulars may be obtained from, and tenders are to be sent to, Le Sous-Secretariat d'Etat des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

Huddersfield.—September 20th. Electrical lighting and other plant for Storthes Hall Asylum. See "Official Notices" to-day.

Isle of Thanet.—Stores for the Isle of Thanet Electric Tramways and Lighting Co. See "Official Notices" to-day.

Johannesburg.—September 18th. The Municipal Council invites tenders for three steel wagons for mounting on standard four-wheel electric tramway trucks provided (with all electric equipment) under another contract.

London.—October 3rd. Low-tension and extra high-tension cables for the L.C.C. See "Official Notices" to-day.

London.—September 29th. Thirty-four tramcar bodies, trucks, equipments, &c., for the L.C.C. See "Official Notices" September 1st.

Mussoorie (India).—October 23rd. Supply and erection of steel power pipes, water motors, alternators with exciters, switchboards complete, transformers, induction motors, pumps, workshop machines; also bare copper overhead mains, insulators, and lightning arresters, arc and incandescent lamps, telephone equipment, workshop tools and general stores. See "Official Notices" July 14th.

Pembroke.—September 22nd. Mains, arc lamps and pillars, meters and switchboard panels, for the U.D.C. See "Official Notices" August 25th.

Pontypridd.—September 30th. Cables and overhead equipment for U.D.C. tramways. See "Official Notices" September 8th.

Simla.—According to *Indian Engineering* the Punjab Government will shortly invite tenders for the electric lighting scheme for Simla.

Spain.—October 14th. The Spanish Ministry of Public Works in Madrid is inviting tenders until October 14th for the concession for the construction and working of an electric tramway in Saragossa. Particulars may be obtained from, and tenders are to be sent to, El Ministerie de Obras Publicas, Madrid.

Switzerland.—The Municipal Authorities of Telf (Tyrol) have just invited tenders for the establishment of a central electric lighting station in the town.

Uphall and Broxburn.—September 18th. The District Lighting Committee of the Parish Council invites tenders for an 80-B.H.P. suction gas producer plant, 80-B.H.P. gas engine, 52-KW. dynamo, reversing booster, batteries, switchboard, cables, meters, &c., for extension of its installation. Specifications, &c., from Mr. A. Lindsay, 11, Jamaica Street, Glasgow (deposit £1 1s.).

Watford.—September 18th. Steel chimney for the electricity department. See "Official Notices" September 1st.

Wemyss.—September 27th. Permanent way for tramways. See "Official Notices" to-day.

CLOSED.

Ashton-under-Lyne.—Messrs. Wilson & Bennett, Ltd., have received a further order from the Corporation Tramways Department for the fitting of its new cars with the company's patent lifeguard.

Australia.—According to *Australasian Hardware and Machinery* the following tenders have been recently accepted:—

Ericsson wall telephones (500) for the Postmaster-General's Department, New South Wales. J. Bartram & Sons, Sussex Street, Sydney.

Plant for the St. Kilda to Brighton electric tramway, Victoria:—

Storage battery, £1,062 12s., motor-driven booster, £166 19s., Noyes Bros.

Overhead line material, £774 13s. 5d., power station switchboard, £157 10s., generating plant, £827 8s., and car motor equipment, £1,160 5s., Australian General Electric Co.

Bradford.—The Corporation has accepted the tender of Messrs. Collinson Bros., of that city, for light and bell fittings for the new Rawson Hotel, for £189.

The Electricity Committee of the T.C. has accepted the tender of the Thornton Engineering Co., Ltd., for the supply of a 10-H.P. De Dion motor-car, at £290.

Brighton.—The T.C. on September 7th adopted the recommendation to accept the tender of the Transporter Co., Ltd., for a coal-handling equipment for the Southwick power station, at £2,321.

Derby.—Messrs. S. Dixon & Son, Ltd., Leeds, have received an order from the Corporation for one Turner's patent automatic point controller as sample.

Malvern.—The U.D.C. has accepted the tenders of Messrs. Page Bros. and Messrs. Santley & Co. for installing the electric light in the new public library.

Salford.—The T.C. on September 6th accepted the following tenders:—Ferranti, Ltd., house meters; Key Engineering Co., Ltd., motor starters; Sperryn & Co., Ltd., tumbler and link switches; St. Helens Cable Co., Ltd., workshop flexible cables; Lancashire Dynamo & Motor Co., Ltd., electric motors; British Westinghouse Electric & Manufacturing Co., Ltd., feeder boosters.

South Shields.—The T.C. has decided to accept the tender of Messrs. Arnold & Son, of Doncaster, for the erection of the car-sheds, in connection with the Corporation tramway system, the amount being £9,425.

Southport.—The T.C. has accepted the tender of the British Insulated & Helsby Cable Co., Ltd., for the supply of switch pillars, one at £17 10s. and four at £25 5s. 7d.

Stalybridge.—The Electricity and Tramway Board has accepted the tender of the British Westinghouse Co. for the supply of an additional machine for the Stalybridge sub-station.

Warrington.—The T.C. has accepted the tender of Hadfield's, Ltd., Sheffield, for the supply of tramway junctions and curves, at £614.

FORTHCOMING EVENTS.

Friday, September 15th, and Saturday, September 16th.—Institution of Mining Engineers. Annual general meeting at Manchester. Visits to the British Westinghouse Co.'s Works, the Manchester Ship Canal, Docks, &c., Messrs. W. T. Glover's Works and the Trafford Light and Power Supply Co. See Note below.

Monday, September 25th.—Opening of the Electrical Exhibition at Olympia.

NOTES.

Electricity Supply in Marylebone.—As mentioned in our note last week, remarkable progress has been made with the new generating station which the Borough Council of Marylebone is erecting for the supply of electricity consumers in its area. The foundations of the station were laid in September last year, Mr. Arthur Wright being the consulting engineer; the station is to contain in the first instance plant of 10,000 KW., consisting of four 500-KW. sets and four 2,000-KW. sets. Of these all but two of the large units are in place. Each set consists of two dynamos coupled to a steam turbine, the larger dynamos generating at 480 volts, whilst the smaller ones run at 240 volts, acting as balancers. The whole of the generating plant, with condensers, &c., is being supplied by Messrs. C. A. Parsons & Co., of Newcastle-upon-Tyne, the dynamos being provided with the special winding recently introduced by that firm to ensure sparkless running. The boilers are of Messrs. Babcock & Wilcox's make, fitted with chain grate stokers and superheaters, and are arranged in a row alongside the engine room. Over the boiler house is a row of cooling towers, an arrangement which we believe has not previously been adopted in this country except at the St. Andrews Station of the Glasgow Corporation.

At an interview last week with Mr. F. A. Wilkinson, electrical engineer and manager to the Borough Council, we learnt that the plant had been running for a month past, and was supplying 4,000 out of the 6,000 consumers. The whole of the consumers will be supplied at 240 volts, but in the meantime there is a variety of pressures in use, varying from 50 volts upwards, in the case of consumers still supplied by the Metropolitan Electric Supply Co. The consumers who were supplied prior to 1896 have the right to appeal to the Board of Trade against the conversion, and two inquiries have been held; the Board sanctioned the change in each case, but the Borough Council is compelled to defray the cost of conversion, re-wiring, &c.

The previously existing rates are being continued for the present, but it is anticipated that the maximum demand system will be adopted, with the following rates:—8d. and 1d. for lighting, the higher rate obtaining for the first 200 hours in each winter quarter, and the first 50 hours in each summer quarter; 2d. and 1d. for power, based on the first 500 hours' use of the maximum demand per annum. A special rate of 2d. per unit will be charged for all-day basement lighting, &c.

The whole of the supply is to be direct current, without sub-stations. Feeder pillars of special design have been adopted, and the old high-pressure house-to-house cables are being replaced with lead-covered triple-concentric distributors, these being convenient for drawing into the existing pipes. Twenty new feeders of 1 sq. in. cross-section have been laid. It must be admitted that very rapid progress has been made with the work, and the Council's engineers are to be congratulated upon the results already attained.

Educational Notes.—The report of the Council of the City and Guilds of London Institute for the year 1904 shows continued progress. The Council has undertaken the extension of the Technical College, Finsbury, at a cost of apparently £10,000, and has found it necessary to call a meeting of representatives of the principal Companies to discuss the financial position of the Institute, the subscriptions last year having fallen to the lowest amount recorded since 1881. It is worthy of note that students' fees, &c., amount to only £19,500, the balance of £24,500 required to carry on the work of the Institute being derived from subscriptions and donations. More than half the cost of the education of a student is, therefore, in the nature of a subsidy, not always, we fear, appreciated by the recipients. A large share of the benefit is bestowed upon the engineering and other firms who profit by the technical knowledge of the students who come to them, at nominal salaries, to gain the experience necessary to complete their training; the unanimity with which the said firms abstain from contributing to the funds and equipment of the Institute is, therefore, more remarkable than praiseworthy.

Prof. Ayrton has been elected Dean of the Central Technical College for the current session; Prof. Unwin has been appointed Emeritus Professor, and is succeeded in the chair of Mechanical Engineering and Applied Mathematics by Prof. W. E. Dalby. Over 110 London University students are in attendance, and the number tends to increase. We are pleased to note that the number of weeks in the college session has been extended to 36; too long vacations are, it is true, traditional in the teaching profession, but that is not the slightest reason why they should be perpetuated, and technical colleges are on a totally different basis from elementary schools. Young children should be lightly worked, but young men should be accustomed to longer hours and fewer holidays, more in keeping with the *régime* to which they will have to submit when they leave college. As a matter of fact, the students strongly object to the excessively long break between July and October.

The number of students admitted has risen from 137 in 1902, and 175 in 1903, to 203 in 1904, and the staff has therefore been increased.

The extension of the Technical College, Finsbury, is being carried out in accordance with the views of the Principal, Prof. S. P. Thompson, assisted by Sir W. White and Prof. Dalby. The last-named has been succeeded in the chair of Mechanical Engineering by Prof. E. G. Coker, late of McGill University, Montreal.

The report deals also with the other departments of the Institute's work, especially that of Technology, in which 41,089 students were registered last year, as compared with 38,638 in the previous year. The value of the Institute's efforts in this connection cannot be over-estimated.

Arrangements have been made at the University of Manchester for a Saturday afternoon course of six lectures on "Electro-metallurgy," by Dr. R. S. Hutton. The first will be delivered on October 14th. The electro-chemical laboratory has been fitted with various types of electric furnaces, and the equipment is believed to be quite unique in this country. The fee for the course is one guinea. The cost of power generation, the different forms of technical and experimental electric furnaces and the materials used in their construction, and the production of the various electric furnace products, will all be considered.

The first section of the magnificent buildings which are in course of erection for the Glasgow and West of Scotland Technical College will be occupied this month; the buildings, when completed, will be the largest of their kind in Great Britain, and will have cost about £300,000. Students of the College are eligible for admission to the privileges of the Carnegie Trust, as well as other scholarships, and the College is affiliated to the Universities of Glasgow and Edinburgh. Prof. Magnus Maclean presides over the department of Electrical Engineering, in which an excellent course of training is provided.

The Calendar of the East London College calls attention to the fact that an Arts side has been added to the College Course, with a view to preparing the students for the examinations in Arts of the University of London. Nineteen scholarships are offered by the Drapers' Co., each of the value of £40 per annum for three years, tenable at the College. Prof. J. T. Morris holds the chair of Electrical Engineering, and complete courses of instruction are provided, leading to the London University examinations for the B.Sc. degree.

Fire.—At an early hour last Saturday morning a fire occurred at the new Post Office telegraph workshop at Mount Pleasant, E.C. The flames were confined to the top floor, an hour's work sufficing to quell the outbreak.

Fatalities.—An inquest was held last week respecting the death of Alfred Herridge, a young assistant master at a Fulham college. Evidence given by W. H. Woods, an electrician, was to the effect that he took deceased over the Lot's Road generating station without permission at night, and when on the cat-walk over the coal-bunkers deceased fell through a space 14¼ in. wide at the side of the gangway on to the concrete bottom of the bunkers 50 ft. below. Mr. Oscar Pilcher, one of the chief engineers of the railway company, said that there was a hand-rail 3 ft. high on one side, and at the other side the belt which carried the coal ran, but the machinery was not running at the time. Witness was called after the accident and assisted to get the body out by means of a pulley. Witness formed the opinion that deceased had tripped over his walking stick. It was a dangerous place, and under no circumstances would witness have taken anyone there at night. The jury returned a verdict of "Accidental death."

A man named John Ayres was killed at the works of the South Wales Electric Power Distribution Co. at Cwmbran. While fixing purlins an iron bar (4 cwt.) dropped out of a sling and fell from a height of 16 ft. on to the head of deceased. The jury at the inquest urged that greater care be taken in tying sling ropes.

Institution of Mining Engineers.—The sixteenth annual general meeting was opened at Manchester on Wednesday, 13th inst., and continues until to-morrow, 16th inst. Among the matters coming before the gathering are a paper by Mr. R. L. Gamlen on "Up-to-date Electrical Power Distribution," and one on "Earth in Collieries, with special reference to the recently issued Departmental Rules," by Mr. S. F. Walker. The excursions include visits to the works of the Lancashire Electric Power Co., the British Westinghouse Co., Messrs. W. T. Glover & Co., Ltd., Trafford Light, Power and Supply Co., and the Stuart Street station of the Manchester Corporation.

The Electrical Side of British Railway Returns for 1904.—The electrical engineer turning to this Blue-Book will feel a certain sense of disappointment. A half-promise in last year's return had given rise to expectations of some special returns concerning lines worked electrically. Some information has been collected, but the form being merely tentative, the information thus acquired is not published. "It is hoped, however, that valuable returns relating to railways worked, or partially worked, by electric traction will be available for publication in the reports relating to future years."

The comparative stagnation in the number of ordinary third-class passengers carried on all the railways still continues, the increase during the year being only 0·6 per cent., and the gross total being 1,092,549,000 for the year ending June 30th, 1904; on the other hand, the number carried on tramways for the year ending March 31st, 1904, was 1,799,343,000. Season ticket-holders are not included in the railway returns, so that this table rather accentuates the magnitude of tramway competition.

In Appendices II. and III. are to be found particulars of the lines worked only by electric power, no enumeration being made of such

undertakings as the Liverpool and Southport, District, or Metropolitan, or the Tyneside lines. The total route mileage of the all-electric systems in England and Wales amounted to 39, all but 3 miles being double. The equivalent track mileage, including sidings, is 85. The total number of passengers carried is just over 97½ millions, the train mileage being 5,526,927. The total receipts from passenger traffic, including mails, luggage, &c., being £771,613. Of the items of general expenditure, maintenance of way is remarkably small, being £38,730, locomotive power (including stationary engines) accounts for £143,342, repairs and renewals of rolling stock cost £165,480, while rates and taxes cost £48,998 (or £1,256 per route-mile). The percentage proportion of expenditure to net receipts averaged 59 for electric railways, against 62 on all the steam-driven railways of the United Kingdom regarded as a single system.

Electric Railway Accidents.—On the 11th inst. a serious accident took place on the New York Elevated (Electric) Railroad; through an error, a train took a curve at an excessive speed and left the rails, one car falling into the street. Eleven persons were killed and 42 seriously injured.

On the Metropolitan Railway, on the same day, an empty electric train ran past the signals and was thrown off the line by the safety points. No one was injured, but some delay was caused to traffic.

On Wednesday this week an electric train ran off the line at Moorgate Street, and blocked the traffic.

It is worthy of notice that none of the foregoing accidents appears to have been in any way due to the electrical equipment. It is unfortunate, however, that these and other mishaps of less importance should occur so frequently, as the general public naturally sets them down to the conversion.

Appointments Vacant.—The Technical Education Board of Wellington, New Zealand, is wanting an instructor in engineering, salary £300, and £40 passage allowance. For forms apply High Commissioner for New Zealand, 13, Victoria Street, London, S.W.; engineer fitter for the Camberwell Guardians (45s.); engineer-in-charge at the Willesden Workhouse Infirmary (£3 3s.).

Football.—The Sheffield Tramways Central Football Club achieved last season the distinction of being the first to win the Municipal Tramways Amateur Football Shield. A league was formed, consisting of the tramways clubs of Liverpool, Manchester, Sheffield, Wigan, and Southport, and as a result of the matches Sheffield secured the leading place with a score of eight matches played, six won, one drawn, and one lost. Eighteen goals were scored for Sheffield, and five against. The shield, which the winners will hold for one year, is a handsome trophy, and last week the Sheffield players received it from Mr. C. R. Bellamy, the general manager of the Liverpool Tramways, who is president of the league. An enjoyable gathering took place, and the members of the Sheffield Club and other guests were entertained to tea by Alderman Clegg, chairman of the Tramways Committee. Alderman Clegg congratulated the Sheffield Club on their success, and Mr. Bellamy presented the shield to the winning team. Sheffield had made an exceedingly good fight, and deserved the victory. For every playing member of the winning team a medal was provided.

The Chemistry of Electroplating.—Writing in the *Journal of the Franklin Institute* (1905, clx., 139), Mr. W. D. Bancroft remarks that when a metal is thrown down electrolytically a pure coherent deposit is required, whether the process is carried out for analytical purposes, or for ordinary plating work. As a rule, a bad deposit is caused by a simultaneous precipitation of some metallic salt, generally an oxide or hydroxide, but, when a cyanide solution is employed, the impurity may be a cyanide. An evolution of hydrogen during the depositing process is not so harmful as often imagined. High current densities, coupled with an agitation of the bath, improve the quality of the deposit by rendering it finer in grain. Generally speaking, the higher the potential difference between metal and solution the finer will be the grain of the deposit. The addition of a colloid to the bath also makes the deposit finer; for instance, a gelatin in a bath of lead silicofluoride improves the appearance of the deposited metal very considerably, and the same rule applies to solutions of copper, zinc, and tin. Very brilliant and almost amorphous deposits may be obtained by the use of a revolving cathode and high current densities. The author observes that the same qualities are needed in a galvanic deposit as in a metallic casting, *e.g.*, absence of air bubbles and mother liquor. In his original paper, Bancroft quotes the composition of the most important solutions containing zinc, tin, nickel, copper, lead, or silver, which are suitable for electrodeposition on the large scale or for analytical purposes.

OUR PERSONAL COLUMN.

[*The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* Electrical Review *posted as to their movements.*]

Central Station Engineers.—The U.D.C. of Bray has appointed Mr. D. E. D. M'Donelln, Macroom, assistant electrical engineer.

The Battersea B.C. has appointed Mr. Ernest S. Colley, shift engineer, to the electricity undertaking. Mr. Colley had been acting temporarily as shift engineer during the past four months.

The Southport Electricity Committee has recommended the T.C. to increase the salary of Mr. A. S. Black, assistant electrical engineer, from £200 to £225 per annum, rising next year to a maximum of £250, on condition that he undertakes to remain at Southport for three years.

Mr. D. C. Redfern has resigned the position of assistant mains superintendent at the Southport Electricity Works, and Mr. W. Travis has been appointed his successor.

The South Shields T.C. on September 6th, by 17 votes to 11, referred back to the Tramways Committee the recommendation that Mr. J. H. Cawthra, the present electrical engineer, should be appointed electrical engineer and tramways manager.

The Colchester T.C. has granted an honorarium of £150 to the electrical engineer, £300 to the borough engineer, and £50 to the town clerk for extra services rendered in connection with the construction of the electric tramways.

The Electric Light Committee of the Coventry City Council decided on Monday to recommend the Council to increase the salary of Mr. J. A. Jeckell, manager of the electricity department, from £400 to £450 per annum. Some time ago it was proposed to raise Mr. Jeckell's salary, but at that time there was a certain amount of opposition, the contention being that it would be better to wait until the results of the year's trading were made known. It was, however, generally felt that Mr. Jeckell was entitled to some advance in view of what he had accomplished in converting a losing concern into one of profit.

Prior to taking up his new duties as chief engineer at West Bromwich, Mr. W. A. Jackson, installation inspector of the Manchester Corporation Electricity Department, was made the recipient of a five o'clock silver tea service on August 25th at the Manchester Town Hall. The chair was taken by Mr. F. E. Hughes, secretary, and Mr. S. L. Pearce, chief engineer, made the presentation. Mr. L. H. Marlor, formerly assistant inspector, has been appointed by the committee as Mr. Jackson's successor, with Mr. W. West as assistant.

Burnley T.C. on September 6th discussed a recommendation from the Electricity and Tramways Committee that a qualified electrical engineer should be appointed to take the entire charge of the generating station, the lighting, the power cables, the destructor, the overhead equipment (including section boxes) of the tramways, and the repair shops, and to act as electrical engineer under any other Corporation or Committee that might require his services. In Committee this was adopted by three votes to two. Mr. Metcalfe, acting-chairman of the Tramways Committee, opposed, and proposed that no change should be made in the duties of the electrical engineer. This motion was carried by 18 votes to 16.

Tramway Officials.—Halifax T.C. has appointed Mr. J. C. Couper, of Newcastle-on-Tyne, as tramway traffic superintendent.

General.—The secretary of the Newcastle Local Section of the Institution of Electrical Engineers is now Mr. Charles F. Proctor, whose address is c/o Messrs. Edison & Swan United Electic Light Co., Ltd., Benwell, Newcastle-on-Tyne.

Mr. W. C. Mountain notifies that his address for future correspondence will be: The Hermitage, Gateshead-on-Tyne.

On September 5th at Rochdale the marriage took place of Mr. John Howard, chief electrician to the Chatterley-Whitfield Colliery, Ltd., Staffordshire, with Miss Emma Cartwright, of Rochdale.

On the 11th inst. the United Chambers of Commerce of Belgium, presided over by Mr. Monnoyer, held a reception at the Bourse in Brussels to receive the delegates of various foreign Chambers of Commerce, who had been visiting the Liège Exhibition. Among Englishmen present were Sir Albert Rollit, M.P., Sir William Holland, Sir Edouard Vivian, and Mr. Parker, M.P. The Anglo-American Chamber of Commerce in Belgium sent as delegates their president and vice-presidents:—Mr. Solomon, managing director of the Txlles-Brussels Electric Light Co.; Mr. Oscar Yoerissen, of New York and Brussels, and Mr. Douglas Wells, M.I.E.E., all being electrical engineers; after the reception the delegates proceeded to the Town Hall, where they were received by Mr. De Mot, the Mayor, and all the aldermen, and in the afternoon were presented to the King of the Belgians.

NEW COMPANIES REGISTERED.

Standard Rubber Co., Ltd. (85,788).—This company was registered on September 8th, with a capital of £2,000 in £1 shares (500 6 per cent. cumulative preference), to carry on the business of manufacturers of and dealers in india-rubber, gutta-percha, leather, vulcanite and celluloid articles, including waterproof and other garments and fabrics, boots, shoes, goloshes, leggings, rubber heels, hose tubing, machinery belting, tires, india-rubber articles used for engineering and electrical purposes, &c. The first subscribers (each with one share) are:—F. Hoff, 189, Hamilton Street, Collyhurst, Manchester, contractor; J. Dearden, 10, St. Oswald Street, Manchester, engineer; J. Wilkinson, 6, St. Oswald Street, Manchester, manufacturer; J. W. Cawley, 65, All Saints' Road, Heaton Norris, Stockport, clerk; W. A. Aspinall, 261, Oldham Road, Failsworth, clerk; S. Baguley, Trinity Place, Ashton-under-Lyne, solicitor; and B. Barrans, 177, Stamford Street, Brooks Bar, Manchester, clerk. No initial public issue. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, £200. Secretary and registered office: J. Wilkinson, 6, St. Oswald Street, Manchester.

British and Continental Traction Syndicate, Ltd. (85,791).—This company was registered on September 9th, with a capital of £500 in 1s. shares (100 deferred) with objects as indicated by the title. The first subscribers (each with one ordinary share) are:—H. H. Rushton, 19, Basinghall Street, E.C., mortgage broker; W. G. H. Monypenny, 53, New Broad Street, E.C., merchant; E. F. D. Sala, Fleet, Hants., stationer; D. J. Paterson, 53, New Broad Street, E.C., secretary; E. O. Cheshire, 21, Finsbury Circus, E.C., merchant; F. Hertzberg, 53, New Broad Street, E.C., gentleman; and H. Bacon, 53, New Broad Street, E.C., secretary. No initial public issue. The deferred shares are to take half the net profits available for distribution in each year after 5 per cent. has been paid on the ordinary shares, and on winding up are to take half the assets remaining after repaying the ordinary share capital. Registered without articles of association. Registered office, 53, New Broad Street, E.C.

Joseph Overend & Sons, Ltd. (85,738).—This company was registered on September 2nd, with a capital of £10,000 in £1 shares, to take over the business of electrical engineers and contractors carried on as Joseph Overend & Sons at Trafalgar Works, Trafalgar Street, Bradford, and to carry on the same and the business of mechanical, hydraulic, gas, mining and general engineers, electricians, makers, storers, suppliers and distributors of electricity for the purposes of light, heat, sound, motive power or otherwise, &c., and to adopt an agreement with Joseph Overend. The first subscribers (each with one share) are:—J. Overend, Cliff View, 114, Midland Road, Bradford, electrical engineer; W. Overend, 3, Cliff Wood View, Bolton Road, Bradford, electrical engineer; H. Overend, Cliff View, 114, Midland Road, Bradford, electrical engineer; Miss A. Overend, Cliff View, 114, Midland Road, Bradford; H. Clapham, 19, St. Paul's Road, Bradford, merchant; S. Hill, 35, Southfield Square, Bradford, cashier; and J. Lund, 5, Charles Street, Bradford, incorporated accountant. No initial public issue. The number of directors is not to be less than two nor more than five; the first are J. Overend (managing director), W. Overend, H. Overend and H. Clapham; qualification, £100; remuneration of managing director, as fixed by the board; of other directors not specified. Registered office: Trafalgar Works, Trafalgar Street, Bradford, Yorks.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

North Wales Power and Traction Co., Ltd. (78,193).—A trust deed dated August 15th, 1905, secure £150,000 5 per cent. first mortgage debenture stock, has been registered. Property charged—(specifically): Freehold land and hereditaments near Conway, certain rent charges, rights, options and premises acquired from J. Tomkinson and H. Platt in 1904; certain freehold land and hereditaments acquired from Sir Richard H. W. Bulkeley, and used as the site for a power station, all other land and hereditaments now or hereafter belonging to the company, the company's general electrical undertaking, all debentures and debenture stock of the North Wales Narrow Gauge Railway Co. acquired or to be acquired by the company pursuant to certain agreements; all paid-up shares and debenture stock of the Portmadoc and South Snowdon Railway Co., or proceeds of the sale thereof to which the company is or may become entitled under an agreement August 9th, 1905, and the benefit of two agreements with Bruce Peebles & Co., Ltd. As a floating security: The company's other assets, present and future. Trustees: Law Debenture Corporation, Ltd., 41, Threadneedle Street, E.C. A mortgage or charge dated August 15th, 1905, to secure £110,000, with interest at 6 per cent., and other moneys as mentioned in the deed, has also been registered. Property charged: (1) £150,000 5 per cent. first mortgage debenture stock (as a specific charge); (2) the company's undertaking and assets, present and future, ranking as a specific charge as regards hereditaments and assets specifically charged by the abovementioned trust deed, and as a floating security as regards other assets, to rank immediately after the said debenture stock. Holders: Law Debenture Corporation, Ltd., 41, Threadneedle Street, E.C.

Switchgear Co., Ltd., Birmingham (85,405).—£3,000 debentures, created 2nd and dated August 3rd, 1905 (bearing 5 per cent. per annum interest and a bonus of £10 per cent.), have been registered. Property charged: The company's general assets, present and future, including uncalled capital. Holder: E. A. M. Bindloss, 45, Beaufort Road, Edgbaston. No trustees.

Frank Suter & Co., Ltd. (57,193).—This company's annual return was filed on July 26th, when 2,050 preference and 13,404 ordinary shares had been taken up out of a nominal capital of £20,000 in 6,500 preference and 13,500 ordinary shares of £1 each. £1 per share has been called up on 2,050 preference and 3,404 ordinary shares, resulting in the receipt of £5,454. 10,000 ordinary shares are considered as fully paid. £1,000 debentures since paid off. Mortgages and charges: £6,000.

J. G. White & Co., Ltd. (66,568).—This company's annual return was filed on July 8th, when 10,000 preference and 50,000 ordinary shares had been taken up out of capital of £200,000 in 15,000 6 per cent. cumulative preference shares of £10 each, and 50,000 ordinary shares of £1 each. £10 per share has been called up on the preference, and £100,000 has been received. £50,000 is considered as paid on the ordinary. Mortgages and charges: nil.

[A prospectus offering the remaining 5,000 preference shares to the public was issued on July 21st, and a list of allotments filed on August 25th shows that the whole 5,000 have been issued.]

Aish's Stores, Ltd. (electric engineers, ironmongers, &c., Bournemouth) (85,440).—£2,000 5 per cent. debentures, created and dated August 30th, 1905, charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees. The debentures are issued to "bearer."

N. S. Electric Storage Co., Ltd. (London) (75,623).—Issue on August 10th of £1,800 debentures, part of series created same date, to secure £20,000, charged on the company's undertaking and property, present and future. No trustees. No previous issue of same series. Agreements on file show that 20 "A" shares of £1 each and 20 "B" shares of 1s. each are to be issued as fully paid in respect of each £100 debenture stock applied for, in accordance with a circular letter sent out by the secretary on July 21st last. The applicants mentioned in the agreements at present filed are G. H. Bower, 4, Bream's Buildings, W.C. (£100); F. J. Mirrielees, 3, Fenchurch Street, E.C. (£500); A. J. Walter, 3, Crown Office Row, Temple (£500); D. Cow, Ryecroft, Streatham Common, S.W. (£200); L. Fuller, Oatlands, 68, Streatham Hill, S.W. (£200); J. F. Swann, 6, East India Avenue, E.C. (£200); and F. W. Hodgshow, 146, Rye Hill, Newcastle-on-Tyne (£100).

Heberlein Co., Ltd., makers of engineering and electrical supplies, &c., London (80,193).—Issue on September 1st of £200 debentures, part of series created February 29th, 1904, to secure £2,500 charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £1,280.

Bastian Meter Co., Ltd. (53,304).—Issue on August 21st of £4 900 6 per cent. debentures, part of series created August 4th, 1905, to secure £6,000 charged on land at Kentish Town, with premises thereon known as 24, Bartholomew Villas, and the company's other assets, present and future, including uncalled capital. Trustees: J. W. Salisbury, Limbrick Hall, Harpenden; and Miss E. Orme, 118, Upper Tulse Hill, S.E. No previous issue of same series.

Simplified Underground Conductor Co., Ltd., Liverpool (76,331).—Issued on August 28th of £1,500 debentures, being the whole of series created same date, charged on the company's undertaking and property, present and future, including uncalled capital. Holder: R. O. Williams, 9, Brompton Avenue, Liverpool. No trustees.

Crompton & Co., Ltd. (27,200).—This company's annual return was filed on August 16th, when 85,000 shares had been taken up out of a nominal capital of £300,000 in 1,000 shares of £3 each. £3 has been called up on 83,000, and £249,000 has been received. £6,000 is considered as paid on 2,000. Mortgages and charges: £100,000.

A. Hirst & Sons, Ltd. (57,889).—This company's annual return was filed on August 2nd, when 100 preference and 310 ordinary shares had been taken up out of a nominal capital of £5,000 in 100 preference and 400 ordinary shares of £10 each. £10 per share has been called up on 100 preference and 10 ordinary, and £1,100 has been received. £3,000 is considered as paid on 300 ordinary. Mortgages and charges: £2,000.

D. Hulett & Co., Ltd. (29,463).—This company's annual return was filed on August 2nd, when 6,000 shares had been taken up out of a nominal capital of £35,000 in 7,000 shares of £5 each. £5 per share has been called up on 1,900, and £9,500 has been received. £20,500 is considered as paid on 4,100. Mortgages and charges: nil.

Edmundson's Electricity Corporation, Ltd. (52,013).—This company's annual return was filed on August 4th, when the entire capital of £800,000 in 80,000 ordinary and 80,000 preference shares of £5 each, had been taken up. £5 per share has been called up on 66,800 ordinary and 80,000 preference, and £734,000 has been received. £66,000 is considered as paid on 13,200 ordinary. Mortgages and charges: £338,930.

Ilfracombe Electric Light and Power Co., Ltd. (71,738).—This company's annual return was filed on July 21st, when 67 shares had been taken up out of a nominal capital of £15,000 in 3,000 shares of £5 each. £5 per share has been called up, and £335 has been received. Mortgages and charges: Nil.

General Electric Co., Ltd. (67,307).—This company's annual return was filed on August 10th, when 25,000 preference and 31,750 ordinary shares had been taken up out of a nominal capital of £800,000 in 40,000 preference, and 40,000 ordinary shares of £10 each. £10 per share has been called up on 18,000 preference, and 6,750 ordinary shares, resulting in the receipt of £247,500. £320,000 is considered as paid on 7,000 preference, and 25,000 ordinary. Mortgages and charges: £200,000.

ELECTRIC TRAMWAY ACCOUNTS.

L.C.C. Tramways.

The following particulars in regard to the working of the L.C.C. Tramways for the year ended March 31st, 1905, are abstracted from the annual statement of accounts. The Southern tramways, comprising some 47 miles of route, are worked by the Council; the Northern section has been leased to, and is worked by, the North Metropolitan Tramways Co., the lease expiring in 1910.

The Southern routes comprise 26½ miles of electric conduit lines, and the remainder are worked by horse traction. Over these routes, the cars (electric and horse) ran 14,081,397 miles, conveying a total of 164,818,560 passengers, out of which 3,150,001 miles were worked by horse traction, 38,563,280 passengers being carried.

The horse tramways earned some £133,799, or 10·19d. per car-mile, the working expenditure amounted to £134,328, or 10·23d. per car-mile, leaving a deficit of £529, or ·04d. per car-mile. The results of the working of the electrical sections were as follows:—

General Statement for 12 months ending March 31st, 1905.

Length of route	26½ miles
Total length of track	53¼ „
Number of cars	401
Car-miles run	10,931,396
Passengers carried per annum	126,255,280
Traffic receipts	£535,754
Total receipts	£548,296
Working expenses	£365,498
Gross profit	£182,798

Income per car-mile		12·04d.
Working expenses per car-mile:—		
Power expenses	2·49d.	
Traffic „	3·43d.	
Repair „	·89d.	
General „	·68d.	
Special „	·54d.	
Total		8·03d.
Profit balance on electrical sections per car-mile		4·01d.

The capital expenditure on the southern system amounted to £2,623,693, being an increase of £499,464 during the year. The gross profit was disposed of as follows:—

Profit Statement, 1904-5.

Deficit on horse sections	£529
Interest and sinking fund, &c.	136,954
Income-tax payment	3,261
Applied to renewals reserve fund	35,000
Balance carried to appropriation account	7,054
Gross profit	£182,798

The capital expended on the Northern system up to March 30th, 1905, was £871,536. The net revenue from the system, after meeting current expenditure, amounted to £58,939, which was reduced to £22,836 by financial charges, &c., the surplus being carried to the appropriation account.

Notes on Electrical Working.—Owing to the fact that the Council's main generating station at Greenwich is not finished, and that energy is either purchased or supplied from temporary plant, the power expenses at 2½d. per car-mile., are very high; this arrangement also limits the number of cars which can be run.

It will be noted that the actual operating expenses amounted to 7·49d. per car-mile, but that a sum of £24,510, or ·54d. per car-mile, utilised in closing the temporary generating stations account, &c., was charged against revenue, bringing the working expenses up to 8·03d. per car-mile.

During the year the Brixton and Streatham cable tramway was reconstructed on the electric conduit system, energy for working it being obtained from temporary plant installed in the Streatham cable depôt; the Bankside station of the City of London Electric Lighting Co. was also drawn upon for working certain routes.

Mr. A. L. C. Fell is the chief officer of the Council's tramways, and Mr. J. H. Rider the electrical engineer to the system.

CITY NOTES.

Hong Kong Electric Co.

This company held its annual meeting on July 15th. Mr. A. G. Wood, who presided, said that the report showed a steady increase in the company's operations, its services now equalling upwards of 34,500 lamps of 8 c.p., 85 arc lamps and 15 lifts, against last year 27,500 lamps of 8 c.p., 85 arc lamps and 12 lifts. The earnings had increased correspondingly, the balance of profit and loss account amounting to $112,199.88, against $99,969.77 last year. It was proposed to pay a dividend of 10 per cent., absorbing $45,000, and write off plant account for depreciation $62,048.76, leaving a balance of $2,151.12 carried forward to next account; the directors would have liked to propose a larger dividend and that a smaller amount be written off, but they had been restrained from doing so by the following considerations:—First, that in all probability they would require to call up the balance of the unpaid capital, $150,000, before the end of the year, and, by paying a 10 per cent. dividend now, they would be in a better position to maintain the same percentage next year on the larger capital, and next because some important alterations were about to be made in their distributing system, that was, they were about to replace the greater portion of their overhead wire service through the Central and Eastern parts of the City by underground cables. This amounted very much to replacing an old system of service by a new one with the sacrifice of the old one. This last, however, quite reached its capacity for service, whereas the new system would enable them to supply a better service through the districts concerned and would allow of extensions into more distant districts as required. The cost of these alterations would amount to about £12,000, and, although there would be considerable improvements, still they were very much replacements of old plant by new, and, as such, had been taken into account in dealing with the distribution of the funds. They were building a new chimney at the works, the present one being found inadequate for requirements. In the month of March last, tenders for lighting the roads in the Peak district were called for by the Government. Accordingly, they put forward one and subsequently learned, with regret, that their application was unsuccessful.

Stock Exchange Notices.—Applications have been made to the Committee to allow the following securities to be quoted in the Official List:—

Anglo-Portuguese Telephone Co., Ltd.—£50,000 5 per cent. first mortgage debenture stock.

Kalgoorlie Electric Tramways, Ltd.—£100,000 5 per cent. "A" debenture stock; and £100,000 6 per cent. "B" debenture stock.

Rosario Electric Co., Ltd.—12,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 12,000; and 8,000 6 per cent. cumulative preference shares of £5 each, £4 paid, Nos. 12,001 to 20,000.

The Committee have ordered the undermentioned securities to be quoted in the Official List:—

Rosario Electric Co., Ltd.—12,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 12,000; and 8,000 6 per cent. cumulative preference shares of £5 each, £4 paid, Nos. 12,001 to 20,000.

South Metropolitan Electric Light and Power Co.—The debenture stock transfer register will be closed from the 20th to the 30th inst. for the purpose of preparing the warrants for the interest payable on October 1st, 1905.

Kalgoorlie Tramways Co.—A meeting of debenture stock holders was held on Tuesday, Mr. A. H. P. Stoneham presiding. The meeting authorised the directors to enter into a supplemental trust deed with the Consolidated Trust, Ltd., who are trustees for the "A" and "B" debenture stock holders. This supplemental trust deed is necessary owing to the company having entered into an arrangement with the Kalgoorlie Power Co. to supply the tramways company with power at cost price, the power company having a percentage of the net profits made by the tramways company over £20,000 per annum.

STOCKS AND SHARES.

Wednesday evening.

Let it be stated at the outset, that the events of the present week provide little material with which to weave financial paragraphs, and the reader will be the more likely to forgive the colourless report that is inevitable in the present case. The change in the Bank Rate made but slight difference to the electricity departments, there are no dividends to write about, no new issues sufficiently near completion to justify a direct reference, and business flows on in a placid steady stream which should make for higher prices being gradually attained.

Notwithstanding the harder and hardening tendency of the Money Market, the stock and shares we deal with are mostly better. The Stock Exchange has received a splendid advertisement from the sudden resumption of speculative activity, and the general public are putting their money into sound securities, such as yield a fair return and have good prospects, rather than into the giddy gambles of the American and South African sections. City of London Electric Ordinary are 11⅛, a rise of nearly 7s. 6d., and this in spite of City Corporation's return to the gas illumination of certain streets. Metropolitan Ordinary are ⅜ harder at 11, and the price looks as though it might go to 12, judging merely from the appearance of the market. Minor improvements are noticeable in Edmundson's Preference, Urban Ordinary and South Metropolitan Preference while the reverse side of the shield is represented by $\frac{1}{16}$ fall in Charing Cross City Preference and 10s. fall in Notting Hill, for which last we have been unable to discover any reasonable cause. Chelsea shed ¼ to 6. Debenture Stocks are unchanged, save for a point rise in that excellent investment, the 4½ per cent. stock of the Midland Electric Corporation, now advanced to 101.

Electric Construction Ordinary continue their quiet progress with another 2s. 6d. rise, making the price £1 middle. The Miscellaneous issues, on the whole, are firm, although the rapid rise in Telegraph Construction shares brought in sellers, and the price is £1 easier at 34½. *Per contra* Brush First Debenture has regained a point of the interest deducted a fortnight ago, and Callender's Debenture came into renewed demand, rising ½ to 110, which makes 2 per cent. up in about a week. Crompton Ordinary hardened ¼ to 1¾, it being understood that the company has recently obtained several important contracts.

Movements in the Telegraph section are very slight, and amongst telephones not a single alteration has occurred. The animation in the American Market produced ½ rise in Commercial Cable Debenture, but Anglo "A" stock is ⅛ easier, which illustrates the advantage possessed by an investment security over a speculative counter. Great Northern Telegraphs eased off 10s. to 35, but a similar fraction was gained by Eastern Telegraph Ordinary. Amazon Debentures retain their pronounced improvement. The Trust companies' descriptions are without change.

Nor is there anything fresh to mention with reference to electrical railway stocks. Central Londons, City and South, Waterloo and City—all the prices of these are the same as they were a week ago. Districts, too, remain at 36, and Metropolitans at 92. Of the traction varieties, British Electric Ordinary recovered ¼ to 8⅛—a reaction after their recent fall. A fairly smart advance leaves British Columbia Electric Deferred at 115½, the Preferred being 104½. Anglo-Argentine Ordinary further receded to 8⅝—a decline of 7s. 6d., holders being disposed in a good many cases to realise their handsome profit, especially as there are rumours that the next dividend may be less favourable than some had expected. Metropolitan Tramways Debenture is good at 106, and Sao Paulo Tramway, Light and Power $100 shares are being negotiated about 145. The 5 per cent. first mortgage Debentures, standing at 101 per cent., ought to be a good and improving investment. Calcutta old shares are 9¾ and the new 9, while Belgrano Ordinary put on a fraction at 3⅜. The "A" Preference at 5¾ and the "B" at 4$\frac{15}{16}$ are also a trifle better.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1902.	1903.	1904.	1905.§	Closing Quotations Sept. 6th.	Closing Quotations Sept. 13th.	Business done week ended Sept. 13th, 1905. Highest	Lowest.	Rise + or Fall —
34,860	African Direct Telegraph, 4 % Debs.	100	4 %	4 %	4 %	..	99—103	99 —102	..	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3 - 3½	3 — 3½	3 5/16	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	..	82 — 87	82 — 87	84	..	..
763,580	Anglo-American Telegraph	Stock	60/6	61s.	2¾%	29s.§	59 — 61	59 — 61	..	..	..
3,118,210	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5¾%	58s.§	105½—106½	106 —107	106⅜	105¼	+ ⅛
3,118,210	Do. do. do. Deferred	Stock	1/-	2s.	Nil	..	15 — 15½	15⅝ — 16	15⅝	14⅞	+ ⅛
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	..	7⅜ — 7⅝	7⅛ — 7⅜	7 7/16	7 1/16	..
1,932,856£	Commercial Cable Stlng. 500 year 4 % Deb. Sk. Red.	Stock	4 %	4 %	4 %	..	96¼ — 98¼	97 — 99	99	98¼	+ ¼
16,000	Cuba Telegraph	10	6¾%	10 %	5 %	..	8⅞ — 9¼	9 — 9¼	9¼	9 1/16	+ ¼
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	..	17½ — 18½	17½ — 18½	..	..	..
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	..	3⅝ — 3⅞	3⅝ — 3⅞	..	..	..
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	..	9¼ — 9¾	9¼ — 9¾	..	..	..
30,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	..	100 —103	100 —103	..	..	..
60,710£	Direct United States Cable	20	3¼%	3 %	3¼%	..	11⅛ — 12	11⅛ — 12⅛	12 1/16	11 13/16	+ ⅛
74,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½%	4½%	4½%	..	100 —102	100 —102	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	..	144 —147	144½—147½	146¾	145	+ ½
2,000,000	Do. 3½ % Pref. Stock	100	3½%	3½%	3½%	..	90 — 92	90 — 92	91½	91½	..
1,836,814	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	..	108 —110	108 —110	109½	108½	..
300,000	Eastern Extension, Australiasia, and China Tele.	10	7 %	7 %	7 %	..	13⅜ — 14¼	13⅜ — 14¼	14⅛	13⅞	..
602,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	..	106 —108	106 —108	107⅛	..	..
800,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 3,000, red. 1909	100	4 %	4 %	4 %	..	99½—101½	99½—101½	..	..	..
200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	..	101¼—103½	101¼—103½%	..	..	..
180,887	Globe Telegraph and Trust	10	£3 16 7*	5¾%	5⅞%	..	10⅜ — 11	10⅜ — 11	10⅞	..	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	..	14⅜ — 14⅝	14⅜ — 14⅝	14 1/16	14⅜	..
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	15 %	24 %	..	35 — 36	34½ — 35½	..	..	— ½
46,500	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	..	100 —102	100 —102	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	..	52⅛ — 54⅛	52⅛ — 54⅛	54½	54½	..
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	..	..	⅜ — ⅝	⅜ — ⅝	..	..	..
1,983,333	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %§	111 —112	111 — 112	112	111	..
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %§	107⅛ - 109½	107⅛—108½	108½	107½	..
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %§	13½ — 14½	13½ — 14½	14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %§	12 — 13	12 — 13	12⅞	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %§	5⅜ — 5⅝	5⅜ — 5⅞	5⅝	5 11/16	..
2,000,000	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	..	99½—100¾	99⅜—101¼	100	99⅜	..
1,689,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	..	104 —106	104 —106	105⅞	105	..
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6¼%	6¼%	..	1 1/16 — 1 1/8	1 1/16 — 1 1/8	..	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	6 %	6 %	6 %	..	1 1/16 — 1 1/16	1 1/16 — 1 1/16	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	..	100 —103	100 —103	..	..	..
11,889£	Reuter's	8	5 %	5 %	5 %	..	7⅞ — 8¼	7⅞ — 8¼	..	..	..
3,237	Submarine Cables Trust	Cert.	6 %	6 %	6 %	..	127 —130	127 —130	127½	..	..
58,000	United River Plate Telephone	5	7 %	8 %	8 %	..	7 — 7⅛	7 — 7⅛	7¼	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	..	5¼ — 5⅝	5¼ — 5⅝	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	..	109¾—111½	109¾—111½	..	..	..
15,509£	West African Telegraph, Shares	10	2 %	4 %	4¾%	..	10 — 10¼	10 — 10¼	..	..	..
30,008	W. Coast of America, 1 to 30,000 & 53,001 to 53,008	2½	Nil	Nil	Nil	..	1/16 — 1/8	1/16 — 1/8	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	..	100 —102	100 —102	..	..	..
207,930	Western Telegraph, Ltd., Nos. 1 to 207,930	10	7 %	7 %	7 %	..	13⅜ — 14¼	13⅜ — 14⅛	14⅛	14⅛	..
75,000	Do. do. 5 % Debs. 2nd series, 1906	100	5 %	5 %	5 %	..	101 —103	101 —103	..	..	..
563,380	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	..	102½—104½	102½—104½	104	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	13/16 — 15/16	13/16 — 15/16	..	..	..
34,563	Do. do. 6 % Cum. 1st Pref.	10	7 %	7 %	6 %	..	8½ — 9	8¾ — 9	8 13/16	8 5/8	..
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	..	6½ — 7	6½ — 7¼	..	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	5 %	5 %	..	101 —104	101 —104	..	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

40,000	British Aluminium 7 % Cum. Pref.	5	Nil	Nil	Nil	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..	..
20,000	Do. do. "A" 6 % Cum. Pref.	5	Nil	Nil	Nil	..	4⅜ — 5⅛	4⅜ — 5⅛	4 1/8	..	..
20,000	Do. do. 4 % Funding Certs.	5	..	..	..	..	2¾ — 3¼	2¾ — 3¼	..	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	..	99 —103	99 —103	..	..	..
133,301	British Electric Traction	10	8 %	6 %	6 %	..	8 — 8½	8¼ — 8⅝	8 1/16	8 3/16	+ ⅛
156,437	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	..	10½ — 11	10½ — 11	10 1/16	10 1/16	..
1,000,000£	Do. do. 5 % Perp. Deb. Stock	Stock	5 %	5 %	5 %	..	123 —125	123 —125	124¼	123¼	..
250,000	Do. do. 4½ % 2nd Deb. Stock Red.	100	..	..	4½%	..	98 — 100	98 —100	99¼	99¼	..
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %§	5⅝ — 6⅛	5⅝ — 6⅛	6⅛	6 1/16	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %§	5⅞ — 6⅛	5⅞ — 6⅛	..	..	..
500,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%§	103 —106	103 —106	..	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	9/16 — 11/16	9/16 — 11/16	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	..	1/2 — 3/4	1/2 — 3/4	..	..	..
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	..	1¼ — 1½	1¼ — 1½	1⅜	..	..
125,000£	Do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	..	90 — 93 xd	91 — 94 xd	..	..	+1
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	..	78 — 81	78 — 81	..	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	..	10 — 11	10 — 11	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	..	5¼ — 5⅝	5⅝ — 5¾	..	..	+ ⅛
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	..	108¾—110½	109 —111	110½	..	+ ½
1,963,208	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %§	90 — 92	90 — 92	91	90½	..
523,396	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %§	101 —103	101 —103	102⅝	..	..
523,396	Do. do. Def. do.	Stock	4 %	4 %	4 %	..	77 — 80	77 — 80	..	..	..
1,330,000	City and South London Railway	Stock	3½%	2¾%	2½%	2 %§	40 — 42	40 — 42	..	..	..
85,000	Crompton & Co., Nos. 1 to 85,000	3	5 %	2½%	2½%	..	1¼ — 1⅝	1¼ — 1⅝	..	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	..	95 —100	94 — 99%	..	..	—1
99,261	Edison & Swan Utd., "A" shrs., £3 pd., 1 to 99,261	5	Nil	Nil	..	..	1⅜ — 1⅝	1⅜ — 1⅝	..	..	..
17,139	Do. "A" shares, 01—017,139	5	Nil	Nil	..	..	2 — 2¼	2 — 2¼	..	..	..
344,023£	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	..	83 — 88	83 — 88	84½	..	..
100,000£	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	..	89 — 94	89 — 94	..	..	..
112,100	Electric Construction 1 to 112,100	2	6 %	4 %	Nil	..	3/4 — 1	7/8 — 1⅛	..	..	+ ⅛
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	7 %	7 %	7 %	..	1¾ — 2¼	1¾ — 2¼	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Sk.	Stock	4 %	4 %	4 %	..	92 — 95	92 — 95	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	..	9½ — 10	9½ — 10	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	..	97 —101	97 —101	..	..	..
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	10%§	12 — 13 xd	12 — 13	12½	12 1/16	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	..	5¼ — 5½ xd	5¼ — 5½	..	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	..	109 —111 xd	109 —111	..	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10 %	5 %	2½%§	15½ — 16½	15½ — 16½	16	15½	..
800,000£	Do. do. 4% 1st Mort. Deb.	100	4 %	4 %	4 %	..	100 —103	100 —103	..	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	1½%	..	2⅞ — 3	2⅞ — 3	..	..	..
10,000	† Do. do. Pref. £13 paid	10	5 %	5 %	5 %	5 %§	9 — 9¼	9 — 9¼	..	..	..
37,380	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	..	34½ — 36½	33½ — 35½	35	34¼	—1
150,000£	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	..	102 —110	102 —104	..	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3 %§	90 — 92	90 — 92	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends. ¶ From Manchester Share List.

Bank rate of discount 3 per cent. (September 7th, 1905).

SHARE LIST OF ELECTRICAL COMPANIES *(continued)*.—ELECTRICITY SUPPLY COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1902.	1903.	1904.	§1905.	Closing Quotations Sept. 6th.	Closing Quotations Sept. 13th, 1905.	Business done week ended Sept. 13th, 1905. Highest	Lowest	Rise + or Fall −
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	† 5	8 %	10 %	10 %	..	9⅜ — 10¼	9⅜ — 10¼	..	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	..	9⅝ — 10⅛	9⅝ — 10⅛	..	..	..
288,782	Central Electric Supply 4 % Guar. Deb. Stock ..	100	4 %	4 %	4 %	..	103 —106	103 —106	105	104¼	..
80,000	Charing Cross and Strand Electricity Supply ..	5	10 %	8 %	8 %	5 %§	6⅜ — 7⅛	6⅜ — 7⅛	..	..	..
80,000	Do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..	—⅛
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	..	4⅞ — 5 1/16	4⅞ — 5	5¼	..	—1/16
40,000	Do. do. 1903	5	4½%	4½%	4½%	..	4⅛ — 5⅛	4⅛ — 5⅛	..	..	..
350,000	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	..	103 —105	103 —105	..	..	..
44,436	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	4⅛%§	6 — 6⅛	6⅛ — 6⅜	..	..	..
150,000£	Do. do. 4½ % Deb. Stock Red. ..	Stock	4½%	4½%	4½%	4½%§	108 —110	108 —110	..	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	..	10⅜ — 11⅛	11 — 11¼	11 1/16	11 1/16	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	..	13 — 14	13 — 14	..	..	..
400,000£	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	..	123 —127	123 —127	126	..	..
300,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	..	103 —105	103 —105	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	4 %§	8¼ — 9	8⅛ — 9	8⅝	8⅝	..
30,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	..	12 — 12½	12 — 12½	..	..	..
400,000£	Do. do. 4½ % Deb. Stock ..	..	4½%	4½%	4½%	..	111 —114	111 —114	112	..	..
250,000	Do. do. 4½ % 2nd Deb. Stock ..	Stock	4½%	4½%	4½%	..	103 —105	103 —105	..	..	..
70,000	Edmundson's Electric Corporation, Ord. Shares ..	5	7 %	7 %	7 %	..	5⅜ — 6⅛	5⅜ — 6⅛	5 1/16	..	..
80,000	Do. do. 6 % Cum. Pref..	..	6 %	6 %	6 %	..	6⅛ — 6⅜	6¼ — 6⅜	6¼	6⅛	+ 1/16
300,000£	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	..	106 —108	106 —108	..	..	..
21,000	Kensington and Knightsbridge Electric Ord. ..	5	10 %	12 %	12 %	..	12 — 12⅜	12 — 12⅜	..	..	..
136,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	..	97 —100	97 —100	98	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	..	2 — 2⅛	2 — 2⅛	..	..	..
60,000	Do. do. do. 6 % Pref...	5	6 %	6 %	6 %	..	4 7/16 — 5 1/16 xd	4 7/16 — 5 1/16 xd	..	..	..
371,895	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	..	99 —102	99 —102	101⅜	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8¾%	10 %	10%§	10⅜ — 10⅞	10⅜ — 11¼	10⅞	..	+⅜
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	..	5⅜ — 5⅝	5⅜ — 5⅝	5⅝	..	..
220,000£	Do. 4½ % 1st Mort. Deben. Stock ..	..	4½%	4½%	4½%	..	109 —113	109 —113	..	..	..
250,000£	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	..	99 —101	99 —101	..	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	..	99 —101%	100 —102%	101½	101	+1
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	..	14 — 15	14 — 15	..	..	..
59,000	Do. do. 4 % 1st Mort. Deb... ..	100	4 %	4 %	4 %	..	100 —102	100 —102	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord. ..	5	14½%	14½%	14½%	10%§	13¾ — 14½	13¾ — 14½	14½	14	..
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %§	8 — 9	8 — 9	..	..	..
150,000£	Do. do. 3½ % Deb. Stock Red. ..	100	3½%	3½%	3½%	..	97 — 99	97 — 99	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	..	2⅛ — 2⅜	2⅛ — 2⅛	..	..	..
50,000	Do. do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	..	76 — 80	76 — 80	..	..	..
65,000	South London Electricity Supply, Ord.	5	1¾%	3 %	4 %	..	3⅜ — 4	3⅜ — 4	3¾	..	..
100,000	South Met. Elec. Lt. & Power Ord..	1	Nil	Nil	Nil	..	1 1/16 — 1 3/16	1 1/16 — 1 3/16	..	..	..
50,000	*(Late Blackheath and Greenwich* 7 % Pref.... ..	1	Nil	7 %	7 %	..	1⅛ — 1⅛xd	1 1/16 — 1⅛ xd	..	..	+1/16
100,000	*Dist. E.L.Co.)* (4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	..	106 —109	106 —109	..	..	..
30,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	..	4 1/16 — 4 3/16	4⅜ — 5	..	..	..
30,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	..	105 —107	105 —107	106¾	..	..
110,000	Westminster Electric Supply, Ord.	5	12 %	13½%	14 %	13%§	12⅜ — 13¼	12⅜ — 13¼	13	12 13/16	..
28,151	Do. do. 5 % Cum. Pref. ..	5	5 %	5 %	5 %	..	6⅛ — 6⅜	6⅛ — 6⅜	..	..	..

Shares not officially quoted :—Mackay Companies, ord., 42—42½. Pref. 76—76½.

† Unless otherwise stated all shares are fully paid. § Interim dividends.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	£*	No. of wks.	Total to date. £	£*	Route miles open.	*
Aberdeen	Sep. 9	2,987	— 196	15	23,194	— 1,426	..	..
†Ayr	Aug. 26	424	+ 21	15	6,272	— 78	8	..
Bath	Sep. 6	1,508	— 135	36	24,534	+ 1,459	13	..
Birkenhead	,, 10	2,278	+ 85	23	25,035	— 418	13·5	..
Blackburn	,, 6	1,954	— 6	23½	23,913	+ 712	14·25	..
Blackpool	,, 7	4,117	— 125	23	33,602	+ 883	11·87	..
,, —Fleetw'd	,, 9	2,481	— 171	10	14,391	— 844	8	..
,, —Lytham	June 22	1,602	+ 753	34	7,608	..	7½	..
Bolton	Sep. 10	3,690	— 70	24	47,208	+ 1,644	26	+ 1
Bournemouth ..	,, 6	3,938	+1,022	..	..	..	13·91	+ 3½
†Bradford	,, 2	4,558	— 558	22	101,317	— 4,594	48	..
Brighton	,, 10	2,463	— 34	24	27,020	+ 786	9·5	..
Bristol	,, 8	10,151	— 638	..	..	..	28·5	..
Brit. Elec. Trac. Co.								
Airdrie	Sep. 1	466	+ 30	35	7,046	+ 25	8·5	..
Barnsley	,, 1	378	— 22	,,	5,679	— 211	3	..
Barrow	,, 1	605	+ 84	,,	8,571	+ 1,920	5·37	..
‡Birmingham (City)	,, 1	9,942	— 176	,,	190,680	+ 3,520	14·5	..
Birmingham (Mid.)	,, 1	2,776	— 614	,,	57,497	+ 2,039	12·25	..
Devonport ..	,, 1	956	— 305	,,	16,354	— 2,426	8·85	..
Dudley—Sto'rb'ge	,, 1	1,978	+ 17	,,	31,863	+ 1,316	21·25	..
Gateshead	,, 1	1,905	+ 20	,,	32,056	+ 601	11·25	..
Gravesend, N'fleet	,, 1	559	— 28	,,	8,207	— 903	6·5	..
Gr'n'k, Pt. Glasgw	,, 1	1,472	+ 121	,,	22,509	+ 2,448	7·25	..
Hartlepool ..	,, 1	640	— 48	,,	9,370	— 1,085	6·72	..
Kidderminster ..	,, 1	293	— 26	,,	4,400	— 249	4·5	..
Leamington ..	,, 1	445	+ 144	7	1,729	+ 813	..	..
Merthyr	,, 1	378	— 40	,,	6,709	— 343	2·9	..
‡Metropolitan ..	,, 1	6,454	+2,104	,,	91,626	+41,783	..	..
Middleton.. ..	,, 1	913	— 48	,,	12,290	+ 602	8·5	..
Oldham — Ashton	,, 1	1,319	+ 16	,,	19,509	+ 284	9·13	..
Peterborough ..	,, 1	307	— 49	,,	4,944	— 439	5·31	..
Potteries	,, 1	3,344	+ 2	,,	58,951	+ 323	29	..
Rothesay	,, 1	1,051	+ 445	,,	7,937	+ 2,233	2·75	..
Sheerness ..	Aug. 30	194	+ 10	,,	2,545	+ 299	2·5	..
Southport ..	Sep. 1	1,037	+ 91	,,	11,438	— 345	8·17	..
South Staffs. ..	,, 1	1,496	+ 147	,,	25,167	+ 293	13·87	..
Swansea	,, 1	1,896	+ 654	,,	24,509	+ 5,214	5·5	..
Taunton	,, 1	124	— 2	,,	1,794	— 189	1·5	..
Tynemouth ..	,, 1	731	— 26	,,	9,653	— 1,004	3·75	..
Weston-s-Mare ..	Aug. 30	800	+ 117	,,	5,440	+ 524	3	..
Wolverhampton D.	Sep. 1	839	— 13	,,	13,721	— 2	14·75	..
‡Worcester.. ..	,, 1	703	— 21	,,	10,840	+ 606	5·75	..
Wrexham	,, 1	221	— 17	,,	3,574	— 338	4	..
Yorks. Wool. Dist.	,, 1	1,398	+ 69	,,	22,752	+ 1,771	17	..
Burnley	Sep. 9	2,228	— 26	..	..	..	7·5	..
†Burton-on-Trent ..	,, 3	323	— 59	22	7,492	— 863	8·5	..
Bury	,, 3	1,571	..	22	16,803	..	10·5	..

Locality.	Fortnight ended.	Receipts for the fortnight. £	£*	No. of wks.	Total to date. £	£*	Route miles open.	*
†Cardiff	Aug. 12	4,941	— 44	19	41,853	+ 605	17·6	..
Carlisle	Sep. 9	385	— 54	36	6,763	— 440	7	..
Chatham and Dist.	,, 7	1,444	+ 121	36	24,194	+ 2,743	9·3	+ ·8
Colchester	,, 6	486	— 205	6	1,580	..	7	..
Cork	,, 7	1,077	— 1	36	17,760	+ 798	9·19	..
Darlington	,, 9	441	+ 27	23	4,863	..	4·87	..
Darwen	,, 9	486	+ 6	23	5,725	+ 249	4·36	..
†Dover	Aug. 12	344	+ 27	32	6,651	— 268	3·5	..
Dublin	Sep. 8	10,799	— 66	..	56,468	+ 7	48·5	+ 1½
Dundee	,, 6	1,836	— 2	..	..	..	..	..
East Ham	,, 11	1,629	+ 135	23	20,109	+ 1,828	6·75	..
Glasgow	,, 9	30,740	+ 843	14½	221,469	+10,829	76	+ 5
Gloucester	,, 6	618	— 131	22½	7,414	..	15	..
†Halifax	Aug. 31	1,681	— 65	22	37,199	+ 1,810	37	+ 4
Huddersfield ..	Sep. 9	2,747	— 49	23	31,898	+ 623	28	..
Hull	,, 9	4,326	— 174	23	51,415	+ 488	13	..
Ilford	,, 2	983	+ 8	24	11,426	— 24	6·5	..
Ilkeston	,, 6	240	— 78	23	2,883	— 614	3·5	..
Ipswich	,, 9	1,013	— 209	23	11,325	— 1,325	10·5	..
Isle of Thanet ..	,, 9	2,702	— 456	36	25,601	— 2,530	11	..
Kirkcaldy	Aug. 30	442	— 45	..	..	..	7·5	..
Lan'kshire Trm. Co.	Sep. 7	1,830	+ 375	36	25,710	+ 2,664	12·5	+ 3·9
Leeds	,, 9	11,753	+ 779	23	145,660	+ 3,191	89·5	+ 8
Leicester	,, 9	4,206	..	36	75,252	..	103	..
Liverpool	,, 2	21,767	+ 407	35	371,349	+ 8,650	103	..
L.C.C.	Aug. 26	31,250	+4,422	21	323,618	+54,890	51½	+ 5½
Lowestoft	,, 26	989	+ 122	..	..	..	..	..
†Manchester ..	Sep. 2	12,772	— 215	22	292,636	+11,884	..	..
Newcastle	,, 2	7,311	— 36	22	85,944	+ 2,808	..	..
Newport	,, 9	1,210	+ 152	23	14,306	+ 2,068	14·5	+ 1·5
Oldham	,, 10	3,075	+ 628	24	40,002	+10,766	23·75	+5·87
Plymouth	..	..	..	..	..	..	..	..
†Pontypridd.. ..	,, 9	162	..	23	3,918	..	3·5	..
Portsmouth ..	,, 9	4,452	— 278	23	53,408	+ 1,624	14·5	..
†Reading	Aug. 10	880	..	19	12,572	— 143	7·5	..
Rochdale	Sep. 9	1,604	+1,110	23	17,951	+14,062	20·5	+14
Salford	,, 4	8,521	+ 69	23	100,562	+ 6,331	..	..
Scarborough ..	,, 9	852	..	36	6,669	..	4·5	..
Sheffield	,, 10	9,603	+ 102	24	119,886	+ 5,192	25·75	+ 2·75
Southampton ..	,, 6	2,164	— 275	23	23,697	— 506	..	..
Southend-on-Sea ..	July 26	1,089	+ 67	17	6,596	+ 468	6·25	..
†Stockport	Sep. 1	900	+ 260	22	16,751	+ 2,876	15·25	+ 4
Sunderland	,, 10	2 792	+ 13	22	32,472	+ 799	..	..
Tyneside	,, 6	821	— 81	36	15,240	+ 1,221	8·87	..
†Warrington ..	Aug. 31	346	+ 14	22	7,598	+ 362	7·75	+ ·25
West Ham	Sep. 7	4,299	+1,954	23	39,890	+16,193	13 25	+ 4·6
Wolverhampton ..	,, 6	1,646	+ 70	23	19,077	..	10	..
Cen. London Rly.	Sep. 9	11,193	— 289	10	56,616	— 1,446	6	..
City &S. Lon. Rly.	,, 10	4,887	— 107	10	22,920	— 330	6·25	..
Dublin-Lucan Rly.	,, 8	314	+ 29	10	1,524	+ 39	7	..
G. N. and City Rly.	,, 9	2,900	+ 597	10	14,285	+ 4,053	3·5	..
L'pool Overh'd Rly.	,, 10	3,005	— 110	..	17,965	— 519	6·47	..
Mersey Railway ..	,, 9	3,113	+ 371	10	15,420	+ 1,037	4·5	..

* Compared with the corresponding period of 1904. † One week only. ‡ Includes horse and other receipts.

REGULATION OF TRANSMISSION LINES.

The drop in volts in a transmission line depends upon the inductive properties of the line as much as upon its resistance, and the factors which enter into the calculation for its determination are the length, size and distance apart of the several wires forming the transmission circuit, the frequency of the current and the power-factor of the load at the receiving end. For a number of years a formula, introduced by the General Electric Co., of America, has been used extensively, in the United States at least, for the determination of the volts lost in the line. The formula in question is—

$$\text{Volts lost in the line} = \text{M} \times \frac{p}{100} \times \text{E}_1 = \quad ,$$

in which p is the percentage of the delivered power lost in transmission, E_1 is the pressure at the receiving end, and M is a constant, the value of which depends upon the characteristics of the line. By transposing the formula we have—

$$\text{M} = 100\,\frac{\epsilon}{\text{E}_1} \times \frac{1}{p} = \frac{\frac{\epsilon}{\text{E}_1}}{\frac{p}{100}},$$

which indicates that M has a simple physical meaning, namely, that it is the value of the ratio of the percentage of the volts lost in the line to the percentage of power lost in transmission, both percentages expressed in terms of the volts and power delivered. Values of M have been given in various "pocket books" for the different conditions occurring in practice, but Dr. Harold Pender points out in the *Electrical World and Engineer*, July 1st, 1905, that these values are wrong, and in the following paragraphs the value of M will be deduced for single and polyphase transmission circuits. In addition to the symbols already mentioned, let—

E = pressure at the generator end,
l = length of each wire = transmission distance,
W = power delivered in watts,
I = current per wire,
r = resistance of each wire per unit length,
x = reactance of each wire per unit length,
$\cos\theta$ = power factor of load at the receiver end.

Fig. 1 is the usual vectorial diagram for a single-phase transmission circuit, in which O I fixes the direction of the current, O E_1 (making an angle θ with O I), represents the receiver voltage in magnitude and phase; O E represents similarly the generator

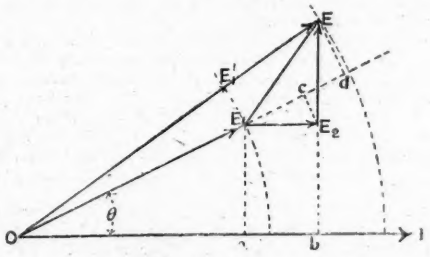

Fig. 1.

voltage; $\text{E}_1\,\text{E}_2$ and $\text{E}_2\,\text{E}$ respectively represent the resistance-drop and reactance-drop in the line. The actual drop in volts in the line is the arithmetical difference between the generator and receiver voltages, and in the figure this drop is given, as regards magnitude, by $\text{E}_1{}^1\,\text{E}$.

From first principles we have for a single-phase line—

$$\text{The line current I} = \frac{\text{W}}{\text{E}_1 \cos\theta}.$$

$$\text{Resistance-drop } (\text{E}_1\,\text{E}_2) = 2\,l\,\text{I}\,r = \frac{2\,l\,\text{W}\,r}{\text{E}_1\cos\theta}.$$

$$\text{Reactance-drop } (\text{E}_2\,\text{E}) = 2\,l\,\text{I}\,x = \frac{2\,l\,\text{W}\,x}{\text{E}_1\cos\theta},$$

and from the geometry of the figure—

$$(\text{O E})^2 = (\text{O E}_1\cos\theta + \text{E}_1\,\text{E}_2)^2 + (\text{O E}_1\sin\theta + \text{E}_2\,\text{E})^2,$$

or
$$\text{E}^2 = \text{E}_1^2\cos^2\theta + \text{E}_1^2\sin^2\theta + 4\,l\,\text{W}\,(r + x\tan\theta) + \frac{4\,l^2\,\text{W}^2}{\text{E}_1^2\cos^2\theta}(r^2 + x^2)$$

$$= \text{E}_1^2 + 4\,l\,\text{W}\,(r + x\tan\theta) + \frac{4\,l^2\,\text{W}^2}{\text{E}_1^2\cos^2\theta}(r^2 + x^2).$$

Therefore, the drop in volts in the line is—

$$\epsilon = \text{E} - \text{E}_1 = \sqrt{\text{E}_1^2 + 4\,l\,\text{W}\,(r + x\tan\theta) + \frac{4\,l^2\,\text{W}^2}{\text{E}_1^2\cos^2\theta}(r^2+x^2)} - \text{E}_1.$$

This equation, although it enables the exact drop in the line to be calculated, is somewhat cumbersome when it is desired to determine M from the relation—

$$\text{M} = \frac{\frac{\epsilon}{\text{E}_1}}{\frac{p}{100}},$$

and Dr. Pender gives an approximate value of M which is less complicated, and correct enough for ordinary cases. In fig. 1 introduce $\text{E}_2\,c$ and E d perpendicular to O E_1 produced; then, as an approximation, we may take $\text{E}_1\,d = \text{E} - \text{E}_1 = \epsilon$, but—

$$\text{E}_1\,d = \text{E}_1\,\text{E}_2\cos\theta + \text{E}_2\,\text{E}\sin\theta,$$

$$\therefore \epsilon\ (\text{approx.}) = \frac{2\,l\,\text{W}\,r}{\text{E}_1\cos\theta} \times \cos\theta + \frac{2\,l\,\text{W}\,x\sin\theta}{\text{E}_1\cos\theta}$$

$$= \frac{2\,l\,\text{W}}{\text{E}_1}(r + x\tan\theta).$$

Now the power lost in the line is given by—

$$p\,\frac{\text{W}}{100} = \text{I}^2 \times 2\,l\,r$$

$$= \frac{\text{W}^2}{\text{E}_1^2\cos^2\theta} \times 2\,l\,r,$$

$$\therefore p = 100 \cdot \frac{2\,\text{W}\,l\,r}{\text{E}_1^2\cos^2\theta},$$

$$\therefore \text{M} = \frac{\frac{\epsilon}{\text{E}_1}}{\frac{p}{100}} = \frac{\frac{2\,l\,\text{W}\,(r + x\tan\theta)}{\text{E}_1^2}}{\frac{2\,\text{W}\,l\,r}{\text{E}_1^2\cos^2\theta}}$$

$$= \left(1 + \frac{x}{r}\tan\theta\right)\cos^2\theta.$$

For unit power-factor of load M = 1, and by using this formula a table may readily be computed for the different sizes of wire,

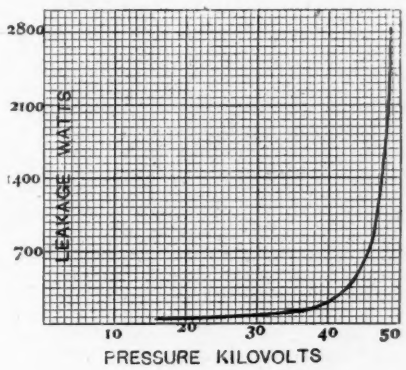

Fig. 2.

different distances apart, and different frequencies. As an application of this formula, a solution to the following problem is given:—

Determine the drop in volts in a transmission system which has to deliver current to a single-phase induction motor of 250 kw. capacity. The receiver E.M.F. is 2,000 volts, and the transmission length is two miles. The wires are No. 0 gauge, and are 24 in. apart, and the power-factor of the motor is 0·82, and the frequency 60 periods per second. The percentage of power lost in the line not to exceed 19·34 per cent. of the power delivered.

Taking one mile as the unit of length, we have—

$$r = 0{\cdot}52 \text{ ohm.}$$

The reactance x (per mile) $= 2\,\pi\,f\,\text{L}$,

in which f is the frequency, and L is the inductance of two parallel straight wires 24 in. apart and 0·325 in. in diameter, each half a mile in length. By Maxwell's formula—

$$\text{L} = 2\,l\left[\cdot 5 + 2\,\log_\epsilon\frac{d}{r^1}\right] \times \frac{1}{10^9} \text{ henrys},$$

d being the distance apart, r^1 the radius of the wire, and l being in centimetres.

$$\therefore \text{L (per mile)} = 5{,}280 \times 2{\cdot}54 \times 12\left[\cdot 5 + 2 \times 2{\cdot}3026 \log\frac{24}{\cdot 1625}\right] \times 10^{-9} \text{ henry},$$

$$= \cdot 001527 \text{ henry}.$$

$$\therefore x = 2\,\pi \times 60 \times \cdot 001527$$

$$= \cdot 5756 \text{ ohm}.$$

$$\therefore \text{M} = \left(1 + \frac{0{\cdot}5755}{0{\cdot}52}\tan\theta\right)\cos^2\theta.$$

Since $\cos\theta = \cdot 82$,
$\theta = 34°\ 51'$ (from tables),
and $\tan\theta = \cdot 6976$,

$$\therefore \text{M} = \left(1 + \frac{0{\cdot}5756}{0{\cdot}52} \times \cdot 6976\right) \times (\cdot 82)^2,$$

$$= 1{\cdot}1916;$$

$$\therefore \epsilon = \frac{\text{M}\,p\,\text{E}_1}{100} = \frac{1{\cdot}1916 \times 19{\cdot}34 \times 2{,}000}{100}$$

$$= 461 \text{ volts}.$$

It will, of course, be observed that the above formula does not include any factor which takes into account capacity and leakage effects. These, however, have to be considered when dealing with long transmission lines and very high pressures. As regards the brush discharge between wires at the higher pressures, Prof. A. Schwartz, of Manchester, communicated the following remarks and curves to the discussion upon Mr. J. F. C. Snell's paper on "Distribution of Electrical Energy" before the Institution of Civil Engineers, November, 1904. Fig. 2 shows the leakage due to brush discharge on a line 2¼ miles long, with wires spaced 15 in. apart, at pressures up to 50,000 volts, and it will be noticed that above 40,000 volts the leakage increased enormously. For this reason it was impossible, at these high voltages, to use successfully

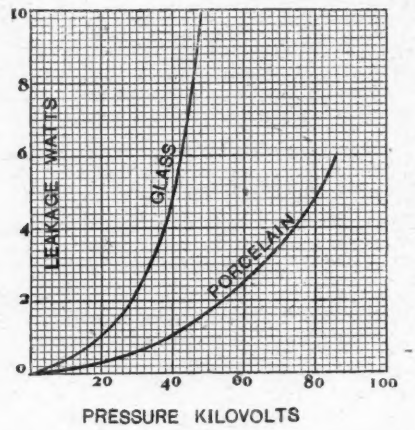

Fig. 3.

wires less than 0·3 in. in diameter, no matter what the amount of energy to be transmitted or the distance of transmission. In such cases, for short lines, aluminium was preferable to copper on account of the larger diameter for the same conductivity. He also referred to the question of leakage over high-tension insulators, and showed by the curves given in fig. 3 that the leakage over wet insulators was not so great as was generally supposed. The insulators tested by Prof. Schwartz were suitable for voltages up to 30,000 volts, and the results given in the curves for 7-in. insulators, of glass and porcelain respectively, when wet, were obtained by increasing the pressure up to 90,000 volts.

A NEGLECTED POINT IN STEAM CONDENSERS.

It is quite common, when calculations are made relative to the volume of air to be dealt with in a condenser, to neglect the law which governs the mixture of gases with saturated vapours. Thus, when the temperature of a condenser is, say, 104° F., the pressure proper to that temperature is 1·06 lb. per sq. in., which represents a "vacuum" of 14·7 − 1·06 = 13·64 lb. by gauge. Supposing, however, that the actual gauge reading is only 13 lb., the additional 0·64 lb. is held to be due to air, and the actual absolute condenser pressure is 1·06 + 0·64 = 1·7 lb. It is very usual to assume that the air in the condenser is present at this pressure of 1·7 lb., neglecting the presence of water vapour.

Thus if air weighs 1 lb. for each 13 cb. ft., its density in the condenser will be assumed to be such that the number of cubic feet per pound will be $13 \times \frac{14{\cdot}7}{2{\cdot}7} = 71$ nearly, and the air pump would require to generate nearly 5 cb. ft. of volume for each cubic foot of air leakage. This view tends to the production of insufficient air pumps.

One of the laws of gaseous mixture is that "the pressure of the whole of a gaseous mass is the sum of the pressures of all its parts." A second law is that "the presence of a foreign gaseous substance in contact with the surface of a solid or liquid does not affect the density of the vapour of that solid or liquid," if there is no chemical combination between the two substances.

Rankine selects as an example in his work on the steam engine, steam at 212° F., 1 cb. ft. of which weighs 0·03797 lb. and exerts a pressure of one atmosphere. The pressure of one atmosphere is exerted by 0·080728 lb. of air at 32° F. If this weight of air be heated to 212° F. it will occupy a cubic foot at the pressure of 1·365 atmospheres. Then if 0·080728 lb. of air at 212° be placed in a vessel of 1 cb. ft. capacity with 0·03797 lb. of steam also at 212° F., their united pressure will be 2·365 atmospheres. Molecular equilibrium demands that each cubic foot of space in contact with water at 212° shall contain 0·03797 lb. of water vapour. Alone the vapour exerts a pressure of one atmosphere. With air added the pressure is increased, yet the boiling point remains the same.

This latter fact is what is ignored, because engineers are so accustomed to consider the temperature, density and pressure above a mass of water to be three invariables. The pressure is invariable where air is not present. It is not, however, a fixed quantity when another vapour is present. Rankine, in further illustration of this law, assumes water at 50° F. and a cubic foot of space containing the invariable 0·00058 lb. of water vapour proper to that pressure, "whether and to what amount so ever air, or any other gaseous substance not chemically attracting the water, is contained in the same space."

This is the law discovered by Dalton and Gay-Lussac. In other words, any amount of gas may be pumped into a space filled with the vapour of water, without decreasing the weight of aqueous vapour previously existing in that space by virtue of the temperature of the water giving off that vapour from its surface.

Recognising the law as correct, the density of the gas present with the vapour may be calculated as follows:—P = the pressure of the mixture, p = the pressure of the vapour proper to the temperature, such, for example, as one atmosphere for water at 212° F.

Then the density of the air or other mixed gas is reduced below that proper to the pressure P in the ratio $\frac{P - p}{P}$. Thus, to take our first example, P = 1·7 and p = 1·06. Then the density of the air $\frac{1{\cdot}7 - 1{\cdot}06}{1{\cdot}7} = 0{\cdot}38$ nearly. The density of air at 104° and 1·7 lb. pressure in pounds per cubic foot is

$$0{\cdot}080728 \times \left(\frac{461 + 32}{461 + 104}\right) \times \frac{1{\cdot}7}{14{\cdot}7} = 0{\cdot}0081 \text{ lb.},$$

or, say, one-tenth of normal atmospheric density. But under the conditions named the density of air in a "vacuum" of 1·7 lb. pressure above water at 104° F. is only 0·38 × 0·0081 = 0·0031 nearly, or practically one-twenty-seventh of normal atmospheric density. Thus there is much less air in the condenser than would be present if the air really had the density corresponding to the pressure. It is, in fact, necessary not to neglect the law of mixed vapours. The pressure in a condenser cannot be greater than that corresponding with the temperature of saturated steam. Any additional pressure, *i.e.*, deficiency of "vacuum," must be caused by air. The presence of this air does not mean that some of the water vapour is pushed back into the condition of water, for the conditions of molecular equilibrium demand the presence of a fixed quantity of vapour per cubic foot of space proper to the temperature. A consideration of the foregoing law will help to explain why it is that the pressure gauge on a boiler will sometimes fall so very rapidly when the engine is started. The steam space of the boiler has been more or less full of air while the boiler has been cold. When heated, the pressure gauge reads the combined pressures of the steam and of the air, and this will be considerably above the pressure proper to the temperature of the boiler. As soon as the air is blown out, the steam pressure shows the actual temperature of the boiler.

Thus, a boiler is closed up tight, and it is then full of air. Feed is admitted, and the air is compressed, say, to 20 lb. absolute. When the boiler temperature is 300° F. the air pressure will be 31 lb., and the steam pressure will be 71 lb. The gauge pressure will be (71 + 31) − 14·7 × 2 = say, 72 lb., and when the air is blown out, the gauge will drop back to 71 − 14·7 = say, 56 lb., being the gauge pressure proper to 300° F. of temperature, whereas the supposed steam pressure of 72 lb. is that proper to a temperature of about 315° F.

In fact, it is possible that by an air trap, a boiler might be 15° F. below its proper temperature, while the gauge was showing full pressure. The fall in pressure will not be noticed when a boiler under these circumstances is put upon the main steam pipe, for its pressure will be maintained either by back flow from the other boilers to which, for a time, it will act as a condenser, or, if the stop valve can only open by pressure from below, there will be no flow of steam until the boiler becomes fully heated. This will explain why the putting in parallel of a boiler at full gauge pressure may not have any effect in helping the work for a few minutes, but may cause the vacuum to drop considerably.

Drop in steam pressure when the stop valve is opened has usually been explained to be due simply to stirring up of cooler water in the lower part of a boiler. This effect is not possible in under-fired boilers, and the explanation is simply as above.

To return to the condenser, however, if the volume, or rather weight, of air in this is not so great as the pressure would signify, but for the law of mixtures the same proportion of such weight will be abstracted by each stroke of the pump.

The fact that air adds so greatly to the pressure in a condenser should, however, spur on the engineer to effect its complete elimination. The degree of approximation of the vacuum gauge to the condenser thermometer is a measure of the degree of elimination of air. A good vacuum gauge would be one with two pointers, which should coincide, if properly made to do so, when no air is present. The lag of the vacuum pointer will show the degree of preventible imperfection.—W. B.

SUPERHEATER PERFORMANCE.

In discussing superheater performance in a paper before the June meeting of the American Society of Mechanical Engineers, Mr. Bement calls attention to the danger which arises with ordinary superheaters when with a brisk fire the load drops suddenly, and reduces the flow of steam through the superheater without lowering the briskness of the fires. Under such circumstances the tempera-

ture of the steam may become dangerously high. Not only may this happen as regards the superheater itself, but it may happen as regards the engines. As a safeguard the very doubtful expedient is suggested of a safety valve on the superheater, so that instead of surplus steam escaping direct to atmosphere from the saturated steam space, it shall all pass by way of the superheater. This expedient will fail where the boiler happens to have lost some of its pressure, as may at times happen, so that there may be a considerable time interval before the safety valve blows.

The only rational method of danger prevention seems to be the Cruse principle of automatic temperature control, wherein the controlling water column is compelled to circulate through the inner tube of the superheater by the action of an inspirator worked by superheated steam. The very fact that the temperature of this begins [to rise is the cause of more energetic water circulation, which takes up most of the additional temperature and prevents excess of superheat. Mr. Bement assumes in his calculations that the specific heat of superheated steam is 0·75 at 180 lb. pressure, but it is probably higher.

These high values have been generally accepted as probable, but Mr. Peake now steps in with his Royal Society paper hinting at a specific heat of 0·46 only, for all temperatures and pressures. No one seems to know the specific heat of water at 200° C. or other high temperatures. Winkelmann, in 1896, gave it as 1·2335 at 180° C. Others give it as but little removed from unity. Whatever it may be, all seem to find it greater than unity, save one or two experimenters. There must be a critical temperature and pressure where steam and water are nearly the same substance in every way, and at that point the specific heat of saturated steam is that of water. Experimenters on the subject need to define their subject more clearly. They want to find how specific heat varies as between steam saturated and steam superheated. It is not easy to think that the values can differ much.

Peake's researches point to low values and to the inaccuracy of Regnault. But they don't explain the coincidence which must surely exist at the critical point. The critical point is said to be about 700° F.

MODERN FIRE WORSHIP.

On March 6th last, Prof. Armstrong, Ph.D., LL.D., F.R.S., &c., delivered an address before the London Section of the Society of Chemical Industry at Burlington House on "The Mechanics of Fire," when he proclaimed himself a fire-worshipper, and made an eloquent appeal to his hearers to become disciples, if not apostles, of the new religion. A study of the chemistry of combustion should be attractive to all chemists, for the subject still remains obscure; it should be attractive to all Britons because (paraphrasing one of Capt. Mahan's titles) of the influence of coal-power on history; and it should be attractive to men of all nationalities whose life work consists in utilising the products derived from the carbonisation, gasification, or "simple" combustion of coal. And yet that terrible Atlantic liner, of which nobody is at present properly ashamed, continues to "eat up coal" at the rate of 24 tons per hour—wasting by far the larger part of the energy, and oblivious "of the curses which posterity will heap upon us if we take no steps to ensure against a recurrence of the ice age."

It would be futile to attempt an abstract or review of Dr. Armstrong's paper. The communication will be found printed at length in the issue of the *Journal*, dated May 15th, where it should be studied by all who aspire to a moral right to consume coal. One point mentioned by Dr. Armstrong is gratifying, viz., that much of the modern investigation into the mechanism of combustion has been carried out by Englishmen—Davy, Frankland, Dixon, Baker, and Bone—although he says that a great part of this work is unrecognised on the Continent of Europe. Here, if it were worth while, we should be inclined to differentiate: one of the leading European nations is certainly more self-centred, or less quick to watch foreign "scientific" progress, than the other. Another point not mentioned by Prof. Armstrong is more important, and might have earned a word of encouragement. Fuel gas engineers are following with much eagerness the results of research and teaching into the chemistry of combustion, and are beginning to devise processes and plant for recovering all the heat latent in coal. Some of the most recent installations for making water gas, efficiently looked after, are surely worth admiration, and may help to moderate the language of our unborn but critical descendants.

It is only about 20 years since Dixon discovered that carbon monoxide (often called carbonic oxide) would not combine with oxygen, or burn, unless moisture were present; but even this circumstance has lost its strangeness since Baker showed that a wet mixture of hydrogen and oxygen, in equivalent proportions, will not explode in the absence of acid impurity or such foreign matter as may be derived from soft glass. We used to be taught to write—

$$H_2 + O = H_2O;$$

and later, when objection was taken to the single atom of oxygen, to say—

$$2H_2 + O_2 = 2H_2O.$$

Now we know that hydrogen peroxide is a constant educt of the reaction, we put something like this—

$$(1)\quad 2H_2 + 2O_2 = 2H_2O_2,$$

$$(2)\quad 2H_2O_2 = 2H_2O + O_2;$$

or, according to electrolytic ideas, and to explain the need for a material to act as catalyser or electrolytic conductor—

$$\begin{matrix} H \\ \dot{H} \end{matrix} + \begin{matrix} H \\ X \end{matrix} > O < \begin{matrix} H \\ H \end{matrix} + \begin{matrix} O \\ \ddot{O} \end{matrix} = \begin{matrix} HOH \\ HX \end{matrix} + \begin{matrix} HO \\ H\dot{O}. \end{matrix}$$

Carbon monoxide appears to burn with intermediate formation of formic acid, although conditions are not usually favourable to the persistence of the latter. The hydrocarbons, methane, for example, are also first "hydroxylated," yielding methanediol $CH_2(OH)_2$, and similar substances, which afterwards decompose into formaldehyde or formic acid, carbon monoxide, and hydrogen.

Such doctrine may, perhaps, not appear of direct practical value to the power raiser; but interest begins to increase when the argument that carbon has a greater affinity than hydrogen for oxygen, because carbon monoxide and hydrogen are found among the products of imperfect combustion of hydrocarbons, is shown to be fallacious. The monoxide and hydrogen are "thermo-schists," not products of oxidation, but products of the decomposition of the primary educts, which are bodies containing both hydrogen and oxygen in their molecules. Again, the fact that excess of oxygen (*i.e.*, air) in a furnace is prejudicial because it increases the loss of heat through the flue gases is well known, if not always taken full advantage of to secure economy; but it is less generally remembered that an excess of oxygen retards the oxidation of hydrogen, carbon monoxide, and some hydrocarbons. In the case of carbon monoxide, the excess of oxygen may produce this damping effect by tending to withdraw water from the sphere of action; but in that of hydrogen it may be the oxygen itself which acts as the effective depolariser, not hydrogen peroxide.

Although he regards combustion or oxidation as an electrolytic phenomenon, and one in which, therefore, some third temporary or permanent body must be at hand to serve as electrolyte, Prof. Armstrong falls foul of certain aspects of the ionic hypothesis, and prefers to define ionisation as a state of "readiness to travel" than as one of actual travel. In a characteristically caustic footnote he points out that nature governs by "attraction and affection," and does not "revel in disruption." He holds up to scorn the doctrine of "suicidal mania" as an attribute of electrolytes, refusing to see the ions "pursuing a lonely existence in the watery wastes of solution." With a passing compliment to the mathematicians and physicists who "have extended our methods of inquiry," he raises the cry of chemistry for the chemists, accusing other men of science of a lack of that fine sense of sympathy and instinct which only intimate knowledge, bred of constant intercourse, can give. In another place, however, he observes that fire often leads to the blowing off of steam.

GLASGOW CORPORATION TELEPHONES: THE LAST PHASE.

At various times in the past few years we have devoted some attention to the Glasgow municipal telephone enterprise, and we have plainly stated our opinion that that enterprise was unsound, financially and technically, and given the reasons for that opinion. The recently published annual report of the Glasgow Telephone Committee amply confirms everything we have said as to the failure of the Glasgow municipality in telephony. Although there is no likelihood of any extension of municipal speculation in telephony, it is worth while to show the astonishing difference between promise and performance in this unhappy branch of municipal trading, because the promises were so explicit and so confident, and so much was built upon them, whereas the performance has been such a complete and crushing failure.

It will be remembered that the Glasgow municipal telephone system was projected on the theory that the average capital cost would be something less than £19 per subscriber's line, and that on this low capital cost an average revenue of £5 odd would pay all expenses, including interest and sinking fund. This was the prospectus, or estimate, put before the Commissioner who held the inquiry at Glasgow in 1897, and before the Select Committee of 1898. Indeed, the Committee of 1898 were assured that the figures of capital cost were not merely estimated, but were a statement of "ascertained cost," since the chief items of the proposed Glasgow plant had actually been tendered for. The Committee were impressed by these assurances, and stated in their report that "the probable cost of such a service in the hands of the Glasgow Corporation is based, not upon estimates alone, but on tenders actually received." When the Glasgow Corporation secured a telephone licence in 1900, they proceeded to build a telephone system on these estimates, and were assured that they might "safely assume that the exchange would be got to work for £19 per line."

The system has now been at work for four years. The total capital expenditure is just under £360,000, and the total exchange lines are 9,634. There are in all 12,362 stations, of which 2,700 are extensions and private line stations of low capital cost and small earning power. Allowing for the capital value of these, the capital cost per exchange line averages over £35, or nearly double the original estimated cost. The business man will see how far the estimates on which municipal telephony was based have miscarried, by a comparison of the estimated percentage of gross revenue to capital with that actually realised. The estimates on which the whole business was based showed that the gross revenue would be 28 per cent. on the capital investment. The present accounts show that the total capital investment is £360,000 and the gross revenue for the year £55,426, just over 15 per cent. It will be seen how utterly delusive the estimates were, when it is considered that, if they had been any real guide to the finances of a telephone business, either the present system should have cost less than £200,000, or the present capital investment should produce over £100,000 of gross revenue. Therefore, looking at the capital account, the Glasgow Corporation have spent over £160,000 more than they ought to have spent, according to the plans on which they founded their telephone business; or, looking at the revenue account, they are earning £45,000 a year less in gross revenue than they ought to be earning on the capital expended.

We have, on several previous occasions, pointed out that the Glasgow telephone estimates have been proved completely erroneous in practice, and our criticisms have been met only by juggling with telephonic terms, by arguments which use "stations" as being synonymous with "lines," by disingenuous statements purporting to prove that an extension instrument is the equivalent of an exchange line, by references to the spare plant provided, and by much sheer misrepresentation of fact. At one time it was the practice of the municipal telephone officials to say that they had so many "spare partially completed lines," to give these lines an estimated value, to deduct the sum thus arrived at from the capital cost, to divide the remainder by the total number of stations of all classes, and to publish the figure thus extracted as a figure comparative with the estimated cost per subscriber's line. This sort of trifling may be useful in town council discussions, or in the *Municipal Journal*, but it is beneath the dignity of anyone calling himself an engineer, although we are sorry to say that some of our electrical contemporaries have made themselves the vehicles for circulating some of the arguments and calculations to which we refer.

The present Glasgow telephone accounts and statistics carry the history of the enterprise up to the end of the fourth year of working, and the results they record are sufficiently clear to dispel the mist of humbug with which the municipal telephone supporters have managed to overcloud the whole subject of telephony. We have been told repeatedly in the past of the large amount of capital invested in "partially-completed spare lines," and of the consequent slight cost that would be involved in joining up new subscribers. This sort of argument is effectively answered by the present report. No less than £29,594 of new capital was expended during the year, and the additions to the exchange lines numbered only 512, of which 207 were party-line stations, occupying, presumably, about 60 actual lines to the exchange. The average cost during the year of additional exchange lines was therefore about £60 per line, in spite of all the previously existing "partially completed spare lines." The total number of stations of all classes, including extension instruments, &c., added during the year was 957, giving an average capital cost of £31 per station added. From this it appears that the average cost per station is going up, as last year it stood at only £28. It is passing strange that municipal telephony, which was to upset all telephonic theories, should give an illustration of the old theory that the cost of doing telephone work increases per unit with the amount of work done. We had expected Glasgow to rise superior to any such ancient notion as this.

The large increase of capital during the year, taken in connection with the very small increase in stations connected, is rather a serious sign. It lends point to a suggestion made some time ago that the Glasgow Telephone Committee have been favouring their working costs account at the expense of their capital account. Further evidence is furnished on this point, by the fact that the admitted working expenses have increased by over £5,300, an increase of more than £5 per station for the new business added during the year. With a relatively smaller amount of capital expended during the year (last year £50,000 of capital was added and the year before £78,500) it has become necessary to distribute a greater proportion of the total annual expenditure to working expenses than formerly, which no doubt accounts for the sharp rise in expenditure charged against revenue this year. But even the present figures for working expenses do not accord with the staff employed, or with the work involved in operating and maintaining a system of 20 exchanges and 12,000 stations spread over a large area. No further capital expenditure on the Glasgow Corporation system is likely to be necessary, as the system is now almost stationary, the new business going to the National system. But there is no doubt that if the system were continued in operation a few years longer, the working expenses would largely increase, both because it would be impracticable to charge expenditure to capital account after the system had ceased to expand, and because it would become increasingly difficult to maintain the service with the obsolete and defective plant employed.

It seems a fortunate turn of events for the Glasgow Corporation that the question of municipal telephony has been settled by Parliament, and that the opportunity is now open to the Corporation to negotiate for the sale of their telephone system to the Post Office, and so get rid of a business which is a failure. The Corporation system is unable to hold its own against the rival service, its technical equipment is such that the service cannot be brought up to modern standards without adopting the heroic method of a general reconstruction, and the enterprise is already heavily over-capitalised. We notice that the Committee make no reference to the question of improving the service, which, it was stated in last year's report, was "under consideration." It was announced early last year that the call-wire working, which has given so much dissatisfaction, was to be abandoned, and the system converted to automatic calling and clearing with lamp signals. Nothing, however, has been done in this direction, presumably because the cost of a complete and effective conversion could not be faced, and the Committee have continued along the mistaken path of extending obsolete plant. The only reference to the small increase of the Corporation system in the past year or so is quite humorous, as follows:—"The negotiations between the Postmaster-General and the National Telephone Co. during the past year, by reason of their creating a condition of doubt as to the future position of municipal telephony, have led to a diminution of telephone work generally." In view of the very active development that has gone on lately in Glasgow "in telephone work generally," this is distinctly good. Apparently the members of the Committee do not read the newspapers.

Although there is now no condition of doubt as to the future position of municipal telephony, we notice that the voice of protest is still being raised in Glasgow, that the *Times* is implored to come to the rescue, that "a new House of Commons" is expected to reverse matters telephonic in favour of the municipal trading enthusiasts, and that in some quarters there is a disposition to regard the five telephone-owning municipalities as martyrs. There is very little common-sense in all this. The vast majority of municipalities throughout the country have never expressed the slightest wish to engage in telephony. The half dozen which have engaged in it have made failures of it, or are well on the road thereto. The municipal systems have been unsuccessful in the competition, and, principally owing to technical errors, their financial condition is unsound. If it had not been for the decision of Parliament, and the Postmaster-General's offer to buy up the municipal systems, those systems would have had to struggle on in a competitive business in which they have been signally unsuccessful up to date, and are daily losing ground. In another year or two all of them would have been in hopeless difficulties. As it is, they have the opportunity of selling out at, presumably, a reasonable price. There is not much martyrdom in that.

REVIEWS.

Practical Alternating Currents and Alternating Current Testing. By C. F. Smith, A.M.I.C.E. Manchester: The Scientific Publishing Co. 1905. Price 6s. net.

This book is written for the use of students in technical schools and colleges, more particularly for those going through a laboratory course on alternating-current work. There are special chapters on transformers, alternators, synchronous and induction motors, and rotary converters. The principles of alternating current working are explained and illustrated by curves obtained from tests on actual machines. Many of these curves are instructive to the beginner, and the directions for making the tests, and the diagrams of connections, are in general easily understood.

The book is fairly complete, and may be considered to be a treatise on the subject. In order to simplify matters, the author in every chapter, except the last, makes the sine curve assumption. This eliminates many of the mathematical difficulties of the subject, and makes the student's progress rapid. He soon acquires a wide knowledge of the working of all kinds of electrical machines, and if he has had a thorough grounding in the elements of electricity and magnetism, he is in a position to specialise on any particular subject. Now, however, he will come across many difficulties, as some of the foundations on which he relies are shaky, and he has not been sufficiently warned of the assumptions that it has been necessary to make in order to simplify the theory.

We are told, for instance, that the self-inductance of a spiral of wire "varies directly as the square of the number (of ?) turns in the spiral, directly as the sectional area of the coil, and inversely as the length" (p. 51). It must vary, however, in a much more special manner with the gauge of the wire used, for keeping the above quantities constant, we can make it as large as ever we please by making the wire thin enough. Again, when there is iron near a coil, the induction linked with the coil is no longer proportional to the current, and so there is *no self-inductance at all.*

The definition of capacity given on p. 97 we cannot understand. "The amount of electricity held by a conductor when its potential is unity is called its capacity." Let us consider the case of a three-core cable with the three cores and the sheath insulated. By the above definition the charge on one core when its potential is unity is its capacity. But if the other cores and the sheath are also at unity potential, there will be no charge on the core, and thus its "capacity" will be zero in this case. It will be seen that by altering the potentials of the other cores, or of the sheath, we can make the "capacity" of the first core, which we suppose maintained at potential unity, anything we please. The author has endeavoured to give the mathematical definition of capacity, but throughout his book he means by capacity the "capacity between two conductors"; and it is in this sense that ordinary electricians use the term. The "capacity" of a sphere equals its radius, but the capacity between two equal spheres may have any value between infinity and half the radius of either, depending on their distance apart.

The meaning is occasionally obscure. For instance, "a wattmeter deflection is always proportional to the watts at any instant (and not to watts^2), and consequently gives the average power" (p. 96). The latter half of the sentence contradicts the first half.

The hybrid word auto-transformer is still used. We call the apparatus an alternating current booster; and if the engineer objects to talk about "boosting down" or "negative boosting," let him call it as the Americans do, "bucking down." Youthful engineers are fond of technical terms; it helps them to maintain the mysteries of their craft.

The treatment of the rotary converter is simple. The assumptions made that the efficiency is 100 per cent., and that the power factor is unity, should have been mentioned oftener. For instance, we could not see at first why the ratio of the alternating to the direct current should be $2\sqrt{2}/3$.

The Heyland diagram of the induction motor is given at length. This diagram is built on so many assumptions that it requires great faith, with which apparently many engineers are plentifully endowed, to use it at all. The last chapter on the analysis of wave forms is interesting and accurate. It fails, however, to show what error is introduced into the determination of the amplitudes and phase differences of the various harmonics, by a small error in the tracing of the original wave—a defect which it shares with all the graphical methods of analysing waves.

It will be seen that our main criticism of the book is not that it simplifies theory at the expense of accuracy, but that it does not lay sufficient stress on the assumptions made. We can easily imagine that a youthful electrician after reading this book, and studying the curves showing the results of tests, would believe himself to be quite capable of testing anything from a choking coil to an induction motor by means of commercial ammeters, voltmeters and wattmeters. It does not conduce to progress to give the impression that everything is beautifully simple, that the difference between "phase difference" and "time lag" is remote from everyday testing, that accurate results can be got by the three-voltmeter method when the power factor is small, or that engineers can calculate hysteresis and eddy current losses in iron with even the roughest accuracy.

A good instance of the passing-over of difficulties is shown in the description of Sumpner's method of testing transformers (p. 171). It is stated without comment that the square root of $a/(a + b) = a/(a + b/2)$ where a is the output and b the losses of a transformer. We can recommend the book to those who wish to obtain a sketchy knowledge of the testing and working of alternating-current machines.

A. R.

Steam Engineering. By W. W. F. Pullen. Manchester: The Scientific Publishing Co. Second Edition. Price 4s.

This belongs to a new class of text-books, of which we have seen several recent examples, in that instead of carrying the reader through the early stages of investigation, he is plunged almost at the outset into modern types and conditions. The older type of text-book, if electrical, dealt with preliminary matters such as pith-balls, electroscopes, and the investigations of Galvani, Volta, and Faraday; if mechanical, there was the inevitable reference to Hero of Alexandria, to Newcomen, Watt and Stephenson; then came thermodynamic definitions, and the phenomenon of latent heat of steam was expounded. The older class of text-books was good enough when private engineering libraries were "one-book" affairs, and that book was supposed to be encyclopædic on its particular subject. Nowadays the conscientious fitter has at least three or four elementary text-books, while the draughtsman will have several standard works such as those of Rankine, Thurston, Clerk &c., and special books on such subjects as steam turbines or the design of valve gears. There is an obvious waste in possessing a number of books, each, say, with plates of early Boulton and Watt engines or illustrations of the "Rocket." Some encyclopædias of the archæology of engineering matters are essential, but that every book should consciously or unconsciously contain a great deal of manifestly redundant matter is by no means desirable. It is necessary, however, that the student buying books of the character of the one under review should have a certain amount of knowledge of steam engines, and be able to read drawings. In his introductory chapter, the author specifies that "a knowledge of elementary mechanics will be assumed when making calculations." "To enable the student to more readily use and appreciate the part played by mechanics," the introductory chapter is therefore devoted to a brief synopsis, the fundamental laws, definitions and common equations of mechanics.

One difficulty, with which all who lecture to engineering students are familiar, is that of securing a continuity of treatment of the subject. If Mr. Pullen's book is to be regarded as a hand-book for the use of these already moderately equipped with a knowledge of steam engines, the reproach of lack of continuity and irregularity of arrangement, which we feel half compelled to apply to it, disappears. Otherwise, the tables given on pages 10-15, with their particulars giving the temperature, sensible heat, latent heat, and so forth at various absolute pressures seems curiously out of place. In these tables also we find the abbreviation B.T.U. for British thermal units. Why cannot the mechanical engineer expand

this abbreviation to B.Th.U. without poaching the electrical engineer's more widely used contraction for the Board of Trade Unit?

The chapter on steam engines does not deal with every type to be found in central stations, but gives typical Corliss-valve engines, high speed vertical engines, and the Parsons, De Laval, Riedler and Rateau turbines. The chief value of the book lies in the succeeding chapters, which deal with the many accessories and the devices which the struggle for efficiency and much ingenuity have evolved. The assistant engineer in any generating station may, with Mr. Pullen's book as his mentor, not only comprehend the mechanical side of his work, and understand other devices capable of substitution for those in use under his eyes, but also by applying the simple methods of testing, lucidly explained, maintain his steam generating gear at the high state of efficiency inseparable from low works cost. To the assistant engineer we can unhesitatingly commend this book. To the student, also, it should possess great value, if the steam engineering laboratory of his college be well equipped. Its value is not to be deprecated even where adequate instructional appliances be lacking, if only the student, in his visits to generating stations, will treat such visits as opportunities for securing knowledge and comprehending the functions of the various devices in use.

Berlin-Zossen Electric Railway Tests of 1903. New York: McGraw Publishing Co. 1905. Price $3.

The magnificent series of experiments on high-speed railway work carried out on the military railroad between Marienfelde and Zossen may truly be described as marking an epoch in the history of modern engineering. Progress is usually attained by a succession of small advances, but these experiments represent a deliberate and successful effort on the part of a research syndicate to excel the best previous records of train speed by nearly 50 per cent. The facts that, given scientific and mechanical engineering, the result was to have been anticipated, and that high-speed lines had been projected for years, in no way detract from the credit due to the gentlemen responsible for this enterprise. They had the confidence required to put the matter to demonstration.

The book before us is an English translation of the report on the 1903 tests, with an introductory essay by Dr. Louis Bell, mainly on the subject of train resistance, and an appendix dealing with a projected high-speed railway between Berlin and Hamburg.

The chief fault we have to find with the book is in no way the fault of the report. A report is made for a limited and special circle of readers, and no objection can be taken to it if it supplies the information required by these readers, although it may not be in a form satisfactory for general publication. The book would have been rendered more valuable had the report been prefaced by a general account, taken from former reports or elsewhere, giving the details necessary to enable one to obtain an accurate conception of the apparatus employed. The descriptive portion of the report is mainly an account of *changes* in apparatus, presumably described in former reports, to which frequent reference is made. Whilst we have, for instance, two plates (VIII and VIII*a*) showing details of a water rheostat, and a cut showing the dimensions of an angle plate forming the side frame of a truck (p. 13), there is no account, or dimension drawing, of the coaches, and no particulars of the motors. Anyone wishing to make use of the results of the tests must accordingly seek elsewhere for the information required to enable him to form a precise judgement as to their application. Had the introduction included this information, instead of being occupied with general appreciation and speculation, the usefulness of the book would have been enhanced.

Elaborate tests of braking retardation, train resistance, air pressure and power consumption were made at various speeds, and many plates are included embodying the results. The train resistance tests do much to clear up the current misconceptions of this important subject, and form a notable addition to our knowledge. We do not agree, however, with the assumption that appears to have been made both in the report (p. 32) and in the introduction (p. X), that the air resistance is to be obtained by measuring the air pressure at various points at the head of the train, or even that it is proportional to this pressure. The head pressure may, in the case of a single car, cause the greater portion of this resistance, but the air friction on the sides of the car and eddying about window frames and wheels must cause an appreciable addition to the air resistance. We should suppose, therefore, that the curve marked "Total friction losses at weight of car 103·2 tons," in Plate XV*a*, obtained by subtracting the estimated head resistance from the total train resistance, really includes a certain amount of air resistance, not necessarily varying according to any simple law, so that Dr. Louis Bell's speculations (p. X) as to the cause of the peculiar shape of this curve appear unnecessary. We see nothing in the tests enabling us to separate the several components of train resistance, and do not consider it possible to do this with any degree of certainty. The train resistance curve may be left to stand as an experimental result, and the air pressure curve is only valuable as accounting for, and showing the law of variation of, one component—the head resistance. It is more accurate and more scientific to leave the result in the form of a curve than to attempt a rational explanation on totally inadequate premises, using the curve to doctor the coefficients in the resulting formula.

The effect of the addition of a pointed nose to the car was investigated and found to result in a marked diminution in the train resistance. It is probable that some further diminution might have been obtained by suitably shaping the rear end of the car so as to avoid the formation of eddies in the air.

An important point brought out during the tests (p. 37) is the absolute necessity of perfect balance in cars intended for high speeds. If serious vibration is to be avoided, the apparatus must be so placed that each wheel of every pair carries the same weight.

The book is well printed, and the plates, which number 38, are very fairly executed. We note, however, that the scale of torque is omitted on Plate XXXVI. The translation is good, although the translator is not always acquainted with English technical terms; his meaning, however, is never in doubt.

F. W. C.

NEW ELECTRIC GLOW LAMP FACTORY.

Last week we had the pleasure of inspecting the factory which has been brought into being by Messrs. Pope's Electric Lamp Co. for the manufacture of incandescent lamps; this factory, which has been in operation for the past six months, is situated in Hythe Road, Willesden, in a district which during recent years has assumed a remarkably busy appearance, owing to the erection of numerous workshops in connection with a variety of small industries.

Naturally, an industry so technical and specialised as the manufacture of glow lamps cannot be established and organised without much labour, and the overcoming of many difficulties, more especially as in this case almost the whole of the employés have been trained by the staff, hardly any of them having been derived from other lamp factories; the process of initiating the work-girls into their duties and weeding out the unsatisfactory hands has been arduous and protracted. Now, however, the work has reached the stage when things run smoothly, and already a large weekly output has been attained, which can readily be increased as the need arises. The buildings which have been adapted for the purposes of the business are well suited to the requirements; the site is freehold, and provides ample space for extensions.

The technical direction of the works is in the hands of Mr. T. R. Pope, who has been connected with glow lamp manufacture from the days when he worked under Mr. (now Sir Joseph) Swan himself in Newcastle; with him is associated his partner, Mr. W. M. O'Connell. Mr. Pope was one of the founders of the well-known firm of Goossens, Pope and Co., of Venloo, Holland, by whom his system is employed;

on the entrance of that firm into the International Syndicate, Mr. Pope decided to commence lamp manufacture in this country. The present firm (Pope's Electric Lamp Co.) while retaining a financial holding in Goossens, Pope & Co., is not otherwise connected with, or in any way controlled by, that firm.

The operations carried on at Willesden comprise the whole of the processes essential to the manufacture of the lamps, with the usual exception of the lamp bulbs, which, we believe, all British firms purchase ready-made from the Continent, and the raw carbonised cellulose filaments, which are at present made abroad. It is intended at an early opportunity to commence manufacturing these also on the premises. The company has made use of the modern automatic methods of glass-working which have so greatly simplified the operations of mounting and sealing the filaments, and has introduced a number of improvements into the processes of supporting and flashing the filaments.

A very high vacuum is obtained in the bulbs by means of a special device; no reliance is placed upon mechanical pumps, the final exhaustion being accomplished with the aid of mercury pumps. Vitrite caps are used, fixed to the bulbs with special plaster in such a way that the connecting wires inside the cap cannot possibly come into contact with the plaster. The finished lamp is of neat and well-made appearance, and recent independent tests show that in the case of the 200-volt 16-c.p. lamp, the consumption of power begins at 3½ watts per candle, and does not exceed 4 watts averaged over a life of 800 hours—a highly satisfactory result.

Messrs. Pope's Electric Lamp Co. have some interesting novelties in hand, of which more will be heard in a few weeks; for the moment we content ourselves with congratulating them upon having successfully inaugurated the supply of "Pope lamps, made in England."

THE STORAGE OF BLAST FURNACE GAS FOR POWER PURPOSES.

The application of the gaseous products of the blast furnace for power purposes by means of gas engines is to some extent complicated by the intermittent manner in which the gas is evolved from the furnaces.

This is due to the fact that the process of smelting iron is interrupted at more or less frequent intervals, according to the practice ruling in the district under consideration, and the ancient or modern methods adopted, for the purpose of casting the iron and running off the slag, as well as on account of other causes, such as irregular working of the furnace, repairs to the tapping or slag hole, &c.

For instance, at some Middlesbrough furnaces, the blast was turned off, and, of course, the process of gas making interrupted, 25 times in 76½ hours for intervals varying in length from 5 to 105 minutes, or an average of 19 per cent. of the total working time. In another case the blast was off the furnace 14 times in 43½ hours, for intervals varying from 5 to 60 minutes, the average being 10 per cent. of the working period.

Again, to quote another instance, the blast was turned off the furnace 8 times in 24 hours, the length of idle period averaging 40 minutes, or 27·7 per cent. of the total, while in three days (24 hours) the blast was turned off 24 times, for intervals averaging about the same length of time, or 22·2 per cent. of the working time.

These instances are not out of the common in blast furnace practice as carried on in many parts of the country, and are only cited to show that though the blast furnace while "on blast" may be considered as an ideal power gas producer, the interval of time during which the blast is shut off the furnace becomes a serious item in regard to obtaining the fullest amount of economy from this fuel source by employing the gas for power purposes. Of course where the only available application of the power possibilities of the "waste" gases of the furnace is to supply the requirements of the furnace itself, the intervals of non-gas producing are not of much importance, as when there is no gas supply there is also no power requirement, but as the blast furnace evolves much more gas than is required for the satisfaction of its own power necessities, the fullest economy can only be obtained by utilising the surplus gases for generating power for some outside purpose; and this by finding profitable employment for the gas continuously as far as the gas production will allow.

Now there are few industries in which the conditions of running would permit of interruptions varying from 5 to 60 or more minutes, and as frequently as three or more times a day, so that to obtain reasonable conditions for the generation of electricity, or other continuous power requirement, it would be necessary to provide some means of storage, to enable the gas engines to work continuously, and turn to profitable account the whole of the surplus gas.

Up to the present time the storage of blast furnace "waste" gas has not been attempted, and therefore a proportion only of the evolved gases has been available for power purposes, the usual method being to allow one furnace, out of three or four, to be available for providing gas during the period when any of the others might be "off blast," from which it will be obvious that where there are only one or two furnaces, the additional profit from the use of the gases for power generation cannot be obtained unless some system of storage is applied. When storage is considered, the first point that strikes one is the fact that bulk for bulk, as far as regards power purposes, the volumes of coal gas and blast furnace gas are about 1 to 5 or 6, the storage of the latter gas, therefore, being more expensive, due to its lower thermal value. In the case of a blast furnace having an output of 1,000 tons per week, the gases available for profitable utilisation would be equivalent to about 3,000 h.p. continuously after supplying the requirements of the furnace itself, but as explained, the evolution of this gas is not continuous, but interrupted by periods varying up to one hour's duration on some days, and occurring as often as three or more times in 24 hours, so it will be interesting to consider the effect of the cost of a couple of gas-holders upon the cost of the gas delivered to the engines, for storage only.

Capacity of gas-holder	15,000 cb. ft.	7,750,000 cb. ft.
Costing, say	£700	£53,000
Period of time during which the holder supply would permit of the engines working (3,000 h.p.) while the blast was "off" the furnace ...	3 minutes.	26 hours nearly.
Allowing 10 per cent. of cost for interest and depreciation ...	£70	£5,300
Charge for storage (on 3,000 h.p.) per h.p. per year	5·6d.	£1 15s. 4d.

These are purposely taken as extreme conditions as regards the capacity, and, therefore, the cost of the gasholders, and even then the highest figure is not altogether prohibitive, while the stand-by period of 26 hours would be satisfactory for the most exigent requirements.

If it were considered that a stand-by storage period of one hour would meet the requirements, then the largest of the holders would be equivalent to supplying 77,500 h.p., and at 10 per cent. the charge for storage per horse-power year would run out to 1s. 5d., showing that this additional cost to be added to the cleaning costs would not be such a serious item as might at first be supposed, seeing that if there were 25 blast furnaces of the capacity selected within reasonable distance, the large gas-holder would serve the lot, even without counting upon the improbability of many of the furnaces being stopped simultaneously.

Electrolytic Preparation of Ammonia.—An electrolytic method of preparing ammonia and caustic alkali has been patented in France by Mr. G. E. Cassel. The various compounds of nitrogen and oxygen which are obtained on passing the electric discharge through air are absorbed in the solution of a caustic alkali, so as to produce a nitrate, nitrite, or mixture thereof. This liquid is then submitted to electrolysis between insoluble electrodes and without a diaphragm, when ammonia is obtained and the caustic alkali is regenerated, the oxygen set free being employed to enrich the air sparked, in order to increase the yield of nitrogen oxides. The patentee finds, however, that the process only gives a satisfactory yield when about 5 per cent. of a soluble lead salt, such as nitrate, is added to the solution; or when the cathode employed is so large that the current density is less than 1 ampere per sq. cm. The mixture of nitrogen oxides can also be absorbed in dissolved or solid calcium oxide or carbonate; but in this case the calcium nitrate or nitrite must be converted into the corresponding alkali salt by treating the solution with an alkali sulphate or chloride.

ELECTRIC RAILWAYS IN GERMANY.

It is understood that the negotiations on the subject of constructing a suspended electric railway in Berlin, which is promoted by the Continental Co. for Electrical Industry, of Nuremberg, will shortly be resumed, and it is possible a decision may be arrived at as to whether this elevated line between the north and the south of the city is to be built. The traffic committee of the Municipal Council have had the scheme under consideration for a period of four years, the project having advocates as equally numerous as its opponents. The plans have been worked out in detail, and one of the principal difficulties has been overcome, inasmuch as it has now been shown that the foundations for the supporting columns can be executed without interfering with the underground network of pipes, a way having been found which will not necessitate their removal. Some time ago the traffic committee requested the company to erect a short experimental section of line, but this was refused, as it is first of all desired to obtain approval of the principle for the construction of the railway.

A proposal has been brought forward for the establishment of an electric railway between Bremen, Bremerhaven, Geestemunde and Lehe. A syndicate of six persons has been formed to promote the scheme, and the necessary capital has been guaranteed for subscription if the Prussian State Railway athourities grant a concession both for the preliminary works and the construction and working of the suggested railway. The railway authorities have already placed statistical information at the disposal of the promoters, who expect that the line would afford a larger range of experience in regard to high speed electric traction than that resulting from the experiments on the Marienfelde—Zossen railway at Berlin. It is stated that negotiations on the subject of the railway have been proceeding between the promoters and the Siemens & Halske Co. and the Allgemeine Electricity Co.

The Prussian Minister of Public Works is in favour of the transformation to electric traction of the Berlin city and circle steam railways, although a definite decision as to the conversion has not been arrived at as yet. In the meantime the Imperial Railway Direction, of Berlin, have decided to establish an experimental line for the purpose of conducting lengthy trials in regard to railway working, and particularly in respect to electric traction, with special reference to the projected change-over on the city and circle lines. The experimental railway, which will be built in the form of a circular line, is to be laid near Oranienburg, and the work of construction will be commenced next year.

The experimental working of the single-phase motor system on the Spindlersfeld railway in Berlin, which has been in progress for a period of two years, is said to have proved itself in every way satisfactory. The motor cars, which have been improved during the course of the trials, and which weigh 52 tons each, are shortly to be withdrawn from the experimental service. As a substitute, the State Railway authorities have handed over to the Union Co. (A.E.G.) a branch line 2·85 miles in length at Hamburg, where motor cars are to be tested. These have been built by a Breslau firm and equipped by the Union Co.; and the total number of cars is 80, each capable of carrying 140 passengers.

The proposed extension of the underground electric railway from Potsdam Platz to the Spittelmarkt, which has been under consideration for a period of eight years, does not appear to make any material progress. As the scheme clashes at one point with the underground railway project of the municipal authorities, the railway company has made a slight alteration in the route, and is about to lay the modified plans before the Council for approval. In the meantime, the communal authorities of the suburb of Schoneberg are negotiating with the company for the working of the proposed underground railway which they intend to build in that part of greater Berlin.

The problem of constructing a high speed electric railway between Cologne and Cassel has recently been discussed by Herr Frankel. It is suggested that the line would shorten the distance by 25 miles, and that by increasing the speed of the steam trains on the Cassel-Berlin route, it would be possible to reduce the time occupied on the journey between Cologne and Berlin by nearly three hours, especially as the electric line would be worked at an average speed of 76 miles an hour. On the other hand, the scheme is said to represent an exceedingly costly undertaking on account of the tunnels and bridges which would be required for a high speed line, so as to reduce the gradients and curves in a hilly country in order to allow of a high speed passenger service.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

17,380. "Improvements in automatic telephone exchanges." C. M. Jacobs and A. H. Nicholson. August 28th.

17,402. "Improvements in and relating to electric cells or galvanic elements and to switching devices for controlling the connections of the same." H. Stern and G. Engisch. August 28th. (Complete.)

17,433. "Improvements in fittings and accessories pertaining to electrical incandescence lamps and the like." W. R. Lambert. August 29th. (Complete.)

17,447. "Improvements in electric meters." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) August 29th.

17,468. "Improvements in alternating current electro-motors." A. H. Middley and B. Reed. August 29th.

17,473. "Improvements relating to electric lampholders." J. Paterson. August 29th.

17,495. "An improved alternating current commutator machine." E. Korrodi. August 29th.

17,521. "Improvements in electrically-driven grinding attachment for metal-turning lathes." H. Humphreys, W. Humphreys and A. Humphreys. August 30th.

17,531. "Improvements in polarised electro-magnets." W. Drury. August 30th.

17,537. "Improvements in telephone spring jacks." W. Aitken. August 30th.

17,643. "Improvements in electrical tractors." L. Gerard. August 31st.

17,653. "Improvements in dielectric separators." A. J. Boult. (H. M. Sutton, W. L. Steele and E. G. Steele, United States.) August 31st. (Complete.)

17,679. "Improvements in connecting wires to binding posts in electric batteries." W. Mills. September 1st. (Complete.)

17,699. "Improvements in or relating to electro-magnetic switches or other electro-magnetic mechanism." M. B. Field and Ferranti, Ltd. September 1st.

17,740. "Apparatus for exploding mines by means of electrical waves." F. Schneider. (Date applied for under Patents Act, 1901, October 25th, 1904, being date of application in Germany.) September 1st. (Complete.)

17,742. "Improvements in artificially-cooled electrical machines." F. W. Howorth. (The Maschinenfabrik Oerlikon, Switzerland.) September 1st.

17,763. "Improvements in and connected with signalling arrangements for electric tramway systems, railways and the like." N. Norrie. September 2nd.

17,764. "Improvements in fittings or appliances for use in connection with cable-suspended electric lamps." F. E. Spittle. September 2nd.

17,772. "An electric signal indicator for railway engines." A. J. Hayter. September 2nd.

17,800. "Improvements in safety fuse apparatus for electrical installations." J. Hartig. September 2nd. (Complete.)

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1904.

Contact Stud and Switch for Use with Surface Contact Systems of Electric Traction. Griffiths and Bedell. 15,778. July 15th.

Apparatus for Use in the Teaching of Electric, Telegraphic, and Other Signalling by Means of the Morse or Other Similar Codes. McDonald. 16,326. July 23rd.

Time Element Devices Applicable to Electric Circuit Breakers and Other Apparatus. Statter. 16,846. August 2nd.

Electric Motor Control Systems. British Thomson-Houston Co., Ltd. (General Electric Co.) 18,201. August 22nd.

Wirelfss Electric Signalling Systems. Dymond. (Ges. für drahtlose Telegraphie m.b.H.) 18,538. August 26th.

Electricity Meters. Hookham. 20,219. September 20th.

Telegraphy. Sheehy. 27,913. December 20th.

Electric Ignition Devices for Internal Combustion Engines. Paxman, and Davey, Paxman & Co., Ltd. 28,122. December 22nd.

Means for the Manufacture of Brasses or Bushes for the Bearings of Shafts, Axles, or the like, more Especially Applicable to Electro-Motors. Thomson and Hanna. 15,312. July 8th.

Automatic Safety Device, Particularly Applicable in Connection with Falling Overhead Trolley Wires, or Other Wires Passing Over, or Running Parallel with, Same. Berry and Risch. 15,344. July 9th.

Memorandum and Like Appliances for Use in Connection with Telephones and for Other Purposes. Gamble. 15,384. July 9th.

Mechanical and Electrical Elevator for Goods, Especially Goods Contained in Sacks. Rubaudo, Estier, Estier, Mallet and Mouren. 15,386. July 9th.

Electric Relays for Automatic Circuit Breakers and the like. Field, Garrard, and Ferranti, Ltd. 15,455. July 11th.

Electric Alarm for Indicating the Heating of Bearings. Thompson. 15,599. July 13th.

Electric Clocks. Bowell. 15,627. July 13th.

Alternating Electric Current Distributing Systems. Merz and Price. 15,796. July 15th.

Compounding Dynamo-Electric Machines for Three-Wire Systems. Allgemeine Elektricitäts-Ges. (Date applied for under International Convention, July 31st, 1903.) 16,728. July 29th.

Control Systems for Electric Translating Devices Particularly Adapted for Use for Controlling Motors on Electrically Propelled Vehicles. British Thomson-Houston Co., Ltd. (General Electric Co.) 17,016. August 3rd.

Self-Regulating Dynamo-Electric Machines. Rosenberg and Rosenberg. 17,423. August 10th.

Telephones. Port. 17,674. August 15th.

Systems of Electric Motor Control. British Thomson-Houston Co., Ltd. (General Electric Co.) 17,813. August 16th.

Electric Plug and Socket Couplings. Richert. 18,046. August 20th.

Electrical Switches. Kennedy-McGregor and Wren. 18,317. August 24th.

Combined Electric Switches and Fuses. Hornby. 18,378. August 24th.

Electric Incandescent Lamps whereby two or more Lamps are Governed by one Central Connecting Cap or the like. Byng and Crawshaw. 18,546. August 27th.

Electric Railways. Carolan. (General Electric Co.) 18,592. August 27th.

Processes of Electro-Deposition. British Thomson-Houston Co., Ltd. (General Electric Co.) 18,840. August 31st.

Metallic Conduits for Electric Wires and Cables. Isherwood. 19,36f. September 8th.

Casing or Conduit for Electric Conductors. McHardy. 19,590. Sept. 10th.

Electrical Telegraphs and Controlling Apparatus. Vyvyan and Newitt. (Secret Document under Section 44, Patents, &c., Act, 1883.) 20,782. September 27th.

1905.

Electric Stop Motions for Looms for Weaving, Warping Machines, and the like. Whittington. (Armstrong.) 3,688. February 27th.

Production of Stereotype Flongs or Matrices, and Apparatus Therefor. Reiter. (Date applied for under International Convention, February 27th, 1904.) 4,041. February 27th.

Electrical Multiple Influence or Condenser Machines. Imray. (Wommelsdorf.) 4,960. March 9th.

Starting Devices for Motors. E. M. L. Batisse and P. A. Drevet. (Date applied for under International Convention, April 23rd, 1904.) 5,772.